Autonomous Vehicles to Evolve to a New Urban Experience

DELIVERABLE

D2.8 Second stakeholder analysis and AVENUE strategies

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Acronyms

AD	Autonomous driving
AV	Autonomous vehicle
CEESAR	Centre Européen d'Études de Sécurité et d'Analyse des Risques
ENGO	Environmental non-governmental organizations
EU	European Union
FIA	Fédération Internationale de l'Automobile
GHG	Greenhouse Gas
ICCT	International Council on Clean Transport
IFEU	Institut für Energie und Umweltforschung
IMP	Integrated Mobility Platforms
IRU	International Road Transportation Union
NGO	Non-Governmental Organization
OEM	Original Equipment Manufacturers
PTO	Public Transport Operator
SAR	Society of Automotive Engineers
ST	Syndicat du transport
UITP	Union Internationale des Transports Publics
URTU	United Road Transport Union
V2D	Vehicle to devices solution
V2I	Vehicle to infrastructure solution
V2V	Vehicle to vehicle solution

1. Introduction

1.1. Background

The AVENUE project aims at full-scale demonstration of urban road transport automation with particular focus on autonomous vehicles in public transportation systems. The elaboration of requirements and use cases for such vehicles and systems is an integral part of the project and crucial for the future success of these operations. This includes state of the art of technology studies, user requirement studies, evaluations of legal requirements, and various other assessments conducted within work package 2 of the project. To better understand the expectations and roles of a multitude of organizations, networks, and institutions involved in realizing public autonomous transportation systems, a stakeholder analysis is one task (2.3) within the work package. The analysis is conducted in several phases and this report summarizes the insights from its initial phase.

1.2. Research domain

A stakeholder analysis is important for the identification of public interest and concern, and becomes even more important due to the increasing interconnectedness of today's world (Bryson, 2004). A stakeholder can be defined as "*any group or individual who can affect or is affected by the achievement of the organization's objectives*" (Freeman, 1984).

A first and crucial step in a stakeholder analysis is the identification and selection of stakeholders relevant to the research domain. There are a number of different techniques available to select the appropriate actors, such as an identification based on involvement, interests, or participation (Hermans & Cunningham, 2018).
The starting point in this study are the actors involved in the AVENUE research project. In a second step, the stakeholder analysis explores further the scope of AVENUE project, comprising other countries in EU and crucial actors from the industry, governments, civil society organizations, non-governmental organizations (NGO's), and so on, that will influence on the future of autonomous driving.

1.3. Methodology

To fully understand the roles and expectations of stakeholders a twofold research approach has been chosen. Firstly, desk research helps to identify the state of knowledge in the field before. Secondly comprehensive empirical research within and outside the AVENUE context enables the validation of the theoretical findings as well as their furthering and specification within the AVENUE domain. Figure 1 displays the overall research design. It might be noteworthy that some steps have been executed simultaneously, wherefore first empirical results became part of the previous deliverable D2.7.

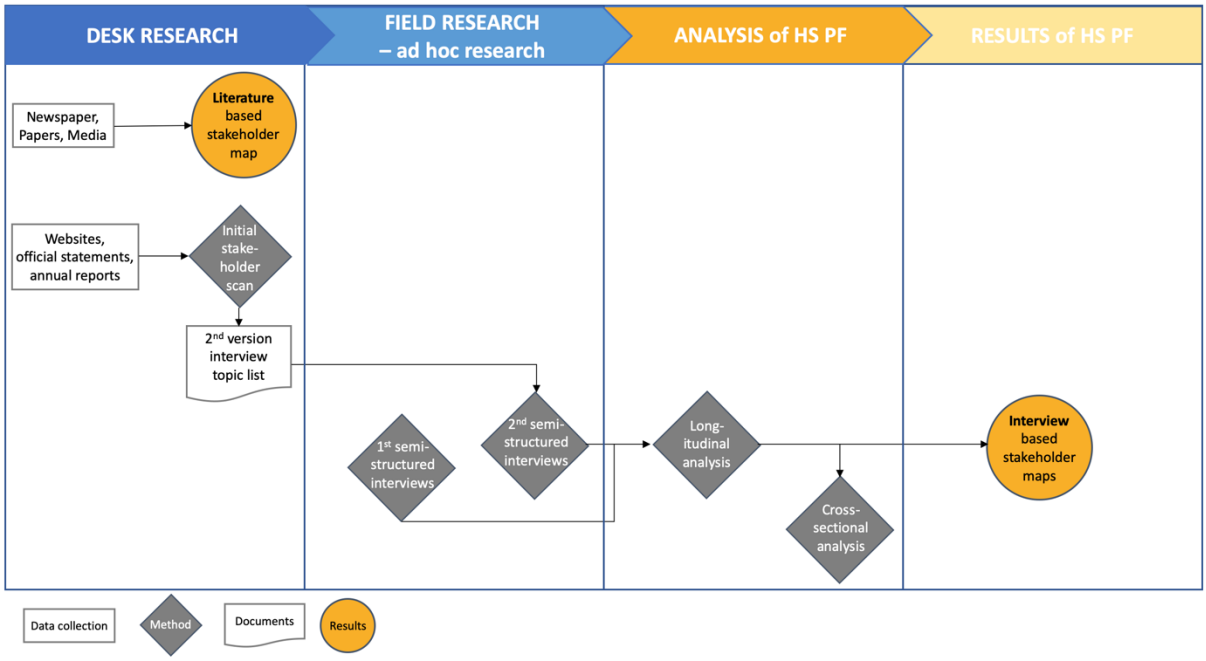

Figure 1: Flow chart for methodological approach

1.4.1. Desk research

As a cornerstone to identify all the potential stakeholders involved on autonomous driving development and implementation in the public transport, an initial stakeholder scan was conducted using the five-step methodology of Hermans & Cunningham (2018).

A stakeholder map was developed based on both, a comprehensive literature review and insights by experts and project partners. As a theoretical model, it aims to identify strategic actors, main mobility trends and their interactions in the process of implementation and integration of autonomous vehicles in the transport systems of European cities.

The steps to conduct the Stakeholder Maps were based on the basic stakeholder analysis technique from Bryson (2004) and on the list of flexible steps for stakeholder analysis (Grimble et al., 1995; Ramirez, 1999). The following steps are included:

- Identifying the purpose of the analysis (Grimble et al., 1995; Ramirez, 1999);
- Literature review based on grey literature reports and news articles;
- Brainstorm the list of potential stakeholders (Bryson, 2004);
- Identifying the stakeholder interests and roles (Grimble et al., 1995; Ramirez, 1999) concerning mobility and autonomous driving;
- Identifying interactions among stakeholders (Grimble et al., 1995; Ramirez, 1999)
- Validation with experts from AVENUE Project.

1.4.2. Empirical research

In coherence with the previous work documented in deliverable 2.7, the explorative, semi-structured, in-depth interviews were applied as methodology for data collection for the selected stakeholder groups. For this, an interview guideline was developed to structure the interviews. The topic-list consisted of five central themes (Appendix II: Topic list):

- Involvement, Attitudes, Expected Trends
- Information behavior

- Focus on autonomous minibuses
- Role of the interviewees' organization
- Identification and perception of other stakeholders

Table 1 displays the sample structure for the interview-based empirical research.

Table 1 Sample structure empirical stakeholder survey

SAMPLE STRUCTURE	
Number of stakeholder groups interviewed	5 target groups
Planned number of interviews conducted	2 to 4 per group
Number of stakeholder interviews conducted per group	
PTO´s/ new competitors	n = 4
Manufacturers	n = 2
Software Developers	n = 3
Driver Unions	n = 3
Environmental NGOs	n = 3

For the qualitative analysis of the interviews, a longitudinal analysis was deployed, comprehending the report of each interview, analysis and presentation of the main findings and a stakeholder map that represents each target group. Contrary to the initial literature based stakeholder map, these stakeholder maps were based on information gathered out of the interviews.
Next research phases following this deliverable will conduct a cross-sectional analysis by compressing the data from interviews, comparing, and gathering the results of each stakeholder.

2. Initial Stakeholder scan

In this chapter, the main findings from the stakeholder scan will be described.

2.1. Identification and selection of stakeholders

An extensive list of stakeholders that are (potentially) involved in the implementation of autonomous minibuses in public transport, was created. To do so, involved actors of the AVENUE project were listed. Hereafter, additional stakeholders were added through a brainstorming session as well as through literature review. Not all stakeholders identified are of similar importance for a successful implementation of autonomous minibuses in public transport. In this section, those stakeholders that appeared to be key actors from the initial stakeholder analysis, will be introduced (Appendix I: Initial Stakeholder analysis matrix).

Important stakeholders are **potential users** of the system. Public support is of crucial importance for a successful implementation of the system. Elements that are important for the creation of public support are: safety, comfort, technology trustworthiness, effectiveness, accessibility and price (Kyriakidis, Happee, & Winter, 2015; Litman, 2019; Nordhoff, Winter, Kyriakidis, van Arem, & Happee, 2018; Wicki & Bernauer, 2018). Recent studies show that potential users are supportive of this new technology (Nordhoff et al., 2018). To increase acceptance, the new technology should be introduced to the public as soon as possible, while simultaneously be advanced and pushed to high-quality level (Salonen & Haavisto, 2019). Furthermore, visual assessments (e.g. lights, signals) and government support increase acceptance (Wicki & Bernauer, 2018). Even though a crucial stakeholder, potential users are not considered in the remainder of this analysis. Potential users are the target group for a separate work package within the AVENUE project (WP8.3 Social Impact Assessment) and will therefore not be included in this analysis. Both work packages do interact frequently, making sure that results from both analyses will be integrated at a later stage of the project.

A first actor group are the developers of the system: the vehicle manufacturers, the software providers and the hardware providers. A distinction between these three actors, as their role and impact differs, was made. These three actors are key actors, as primary innovators and proponents of the system.
Manufacturers of autonomous minibuses are important stakeholders. NAVYA, the manufacturer of the minibuses in the AVENUE project, has as primary goals offering new mobility solutions, establishment of a good market position, and consumer confidence/acceptance. In order to do so, they focus on implementing their products in public systems as soon as possible. Well-drafted standards can increase the rate of development and reduce overall system cost per vehicle. NAVYA, being one of the strongest competitors due to their high technology development, and raising more than €30 million euros in 2018 makes them an important and attractive stakeholder for the AVENUE project. Other manufacturers have similar goals and are as crucial for a successful implementation of the system.

Software providers offer platforms that enable the intelligent operation and optimization of autonomous mobility services, managing fixed-route and on-demand services. These cloud-based platforms are crucial for the system to function. Furthermore, the platform should also function as the interface between vehicles, between travelers and mobility providers. Software providers are crucial stakeholders, as an autonomous system cannot function without a proper software platform.

The prime objective for **public transport operators** is to seek high market share and good market positioning. Public transport operators are responsible for the public transport system to function. In

order to stay competitive, they have to innovate and reduce costs. The installment of autonomous minibuses could be a solution to pursue both goals; as this system is both more flexible, due to the smaller sizes of the buses and its possibility to drive 'on demand', as well as it can be more cost-effective, as it reduces personal costs. However, public transport operators are also holding back, as recent studies show that development of autonomous vehicles could result in public transport losing its attractiveness due to innovative services, such as on-demand taxi services and private car-pooling. All in all, public transport operators are important stakeholders in the development of a system of autonomous minibuses but are not crucial; their role could be overtaken by **new competitors** that share similar objectives. In addition to increasing their market share and market positioning, they pursuit to gain consumer's trust by offering innovate mobility systems. To do so, new competitors will have to face constant evaluation and comparison of competitors, seek for partnerships, and adapt ideas and methodologies. Hence, all involved competitors are focusing on developing the most innovative, secure and trustworthy vehicle for the market. Nowadays, there are various rising competitors such as *Easy mile* or *Holo*, interviewed as A-mobility, which are currently, as Navya, exploring the challenges of autonomous driving in different cities for instance Appelscha, The Netherlands (Boersma, van Arem, & Rieck, 2018).

A current barrier for the establishment of fully-functional autonomous minibus systems, are regulations that require stewards on board (Ainsalu et al., 2018). The **European Union (EU)** is an important actor in this respect. Promoting autonomous driving will challenge the EU to create incentives and regulations and remove possible barriers that can stop the development of this technology. Currently, the EU is supportive of this development, through stimulating innovations and knowledge creation by funding large-scale research projects, such as AVENUE, under the Horizon2020 programme.

The EU can develop general guidelines and policies, but it is up to the member states (they will be referred to as countries) to develop regulations, incentives and rules. There is great differentiation on the level of application between different countries and cities. Some countries within the European Union already offered space for experimentation with autonomous vehicles on public roads (such as France, the Netherlands, Luxembourg and Germany), whereas others are more conservative. The same accounts for local level government, where cities like Copenhagen, Lyon, Geneva, and Luxembourg show a high interest in conducting field experiments. On a city level, it is not so much the formal rules and regulation that are key resources, but local incentive structures – mobility policy, willingness to adapt road infrastructure etc. – that are crucial for a successful system of autonomous minibuses. Overall, both state-level and city-level governments are crucial stakeholders as they must provide an enabling institutional environment for the system to function.

A strong opposing position is taken by **unions of transport operators,** as bus drivers fear to lose their jobs once autonomous minibuses are in place (Austin, Bucknor, Cashman, & Rockeymoore M., 2017). The unions would favor an automatic unemployment assurance, provide education and retraining for the transport operators to find comparable or even better jobs, and expand support for displaced workers to start and sustain their own business (Austin et al., 2017).

Other stakeholders, like Insurance companies, electricity charging infrastructure, energy providers, environmental non-governmental organizations (ENGO), Recycling industry, Emergency aids, Industry lobbies (such as Society of Automotive Engineers (SAR), International's On-Road Automated vehicle Standards committee, etc.), Trade unions, Research institutes, Consultancy companies, and the United Nations, were identified but will not be further detailed in this part, as their influence is, not yet, crucial for the project's success.

2.2. Stakeholder analysis based on existing studies

In the previous section, the main stakeholders, based on the initial stakeholder scan were identified and discussed. The actor scan and the iterative mapping of the actor characteristics form the basis for the analyses presented in this section. These analyses provide visual insights into the interest, power, attitudes, impacts and relations of involved stakeholders.

2.2.1. Power-Interest grid

The first analysis is the power-interest grid (Figure 2: Power-Interest grid towards the implementation of autonomous vehicles in the public transport system). In a power-interest grid, power and interest of particular stakeholders are used to classify different actors (Hermans & Cunningham, 2018). Stakeholders are placed on this grid, based on their interest (high or low) in the topic, and to their power (high-low). Power is defined by the resources possessed by an actor, and the relative importance of these resources in the implementation and feasibility of the system. The graph also points the supportive, opposing, ambivalent, or indifferent positioning of the actors. A power-interest grid is dividing the stakeholders into four quadrants, also providing implications for analysis. Actors in the quadrant in the upper-right (high power/high interest) are key players and should be taken along in the analysis. Actors in the quadrant in the bottom-right (low power/high interest) are so-called context-setters, and could be taken along in the analysis, depending on the boundaries of the analysis. The actors on the left side of the grid could in principle be left out (Hermans and Cunningham, 2018).

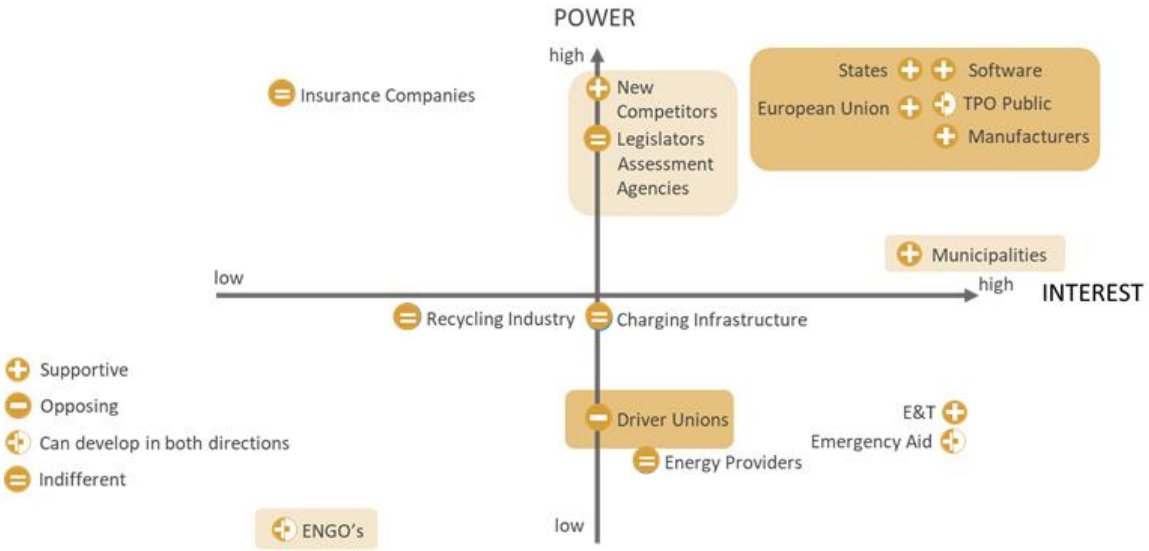

Figure 2: Power-Interest grid towards the implementation of autonomous vehicles in the public transport system

According to the power-interest grid, the countries, European Union, Software Providers, Manufactures and the Public Transport Operators are key actors with high power and high interest. The countries and EU have high institutional power to influence and to set policies, regulations and incentives favorable to autonomous vehicle's (AV) implementation. Software Providers and Manufactures are strategic for the AV's technical feasibility and daily improvements. The Public Transport Operators are key operational actors and the bridge between the new mobility technology and society.

New competitors, such as start-ups proposing new services and products on mobility, **present high power and medium interest.** Legislators have a high power since they are responsible to set the laws

and specific conditions for the implementation of AV's. Municipalities present medium power and high interest in the AV's as a source of innovation, attractiveness, sustainability and improvements for the transport system.

Secondary, but interesting actors, are the drivers' union, with an opposing positioning due to their fear to lose their jobs, they present medium interest in the topic and low power. The environmental NGO's are divided and can be supportive or opposing to the AV's implementation. Once this technology present pros and cons, it is still in development and test, and it depends on proper policies, incentives and sustainable business models to trigger positives impacts on mobility.

2.2.2. Impact-Attribute grid

The second analysis, the Impact-Attitude grid places the actors according to their opposing, neutral or supportive attitude towards a project and the high or low impact that they represent towards the integration of AV's on mobility (Figure 3: Impact-Attitude grid representation regarding the implementation of autonomous vehicles in the public transport system) (Demir et al, 2015; Zimmermann and Maennling, 2007).

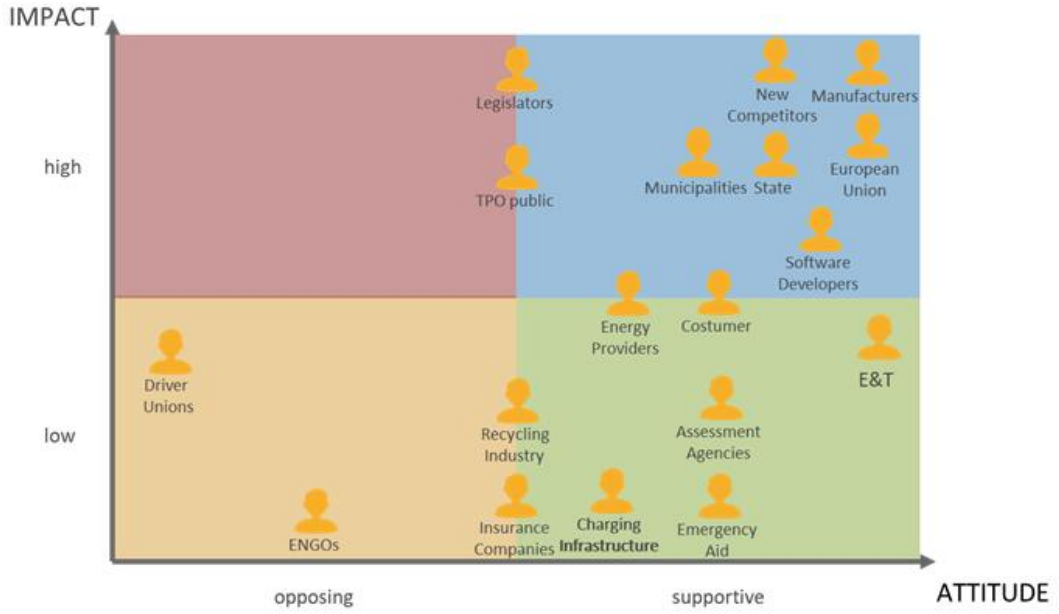

Figure 3: Impact-Attitude grid representation regarding the implementation of autonomous vehicles in the public transport system

The majority of actors, either with high or low impact, have a supportive or neutral attitude concerning autonomous minibuses in public transport sector. The driver unions and environmental NGO's present a low impact and opposing attitude, and due to this fact, these actors have to be taken on board on discussions and decision making in order to mitigate potential negative impacts on society and environment.

So far, no actor with high impact and opposing attitude was identified. This means that there are no stakeholder actors threatening the project's success, currently. Thus, it is of importance to keep an eye on further development of the position of each stakeholder, and respond appropriately once stakeholder groups will change their attitude towards the project.

2.2.3. Onion diagram

As third analysis, an onion diagram is presented in Figure 4: Stakeholders Onion Diagram concerning the implementation of autonomous vehicles in the public transport system. An onion diagram represents a structure organized into circles representing different levels. At the center, the primary level places the stakeholders with significant influence in the project and strong control over essential resources regarding AV's and public transport (Cziscke, 2018; WRI, 2015). Therefore, a high and direct impact is assumed.

At the secondary level, stakeholders with relevant importance for the project and medium control over essential resources are placed. The wider environment is represented at the tertiary level, including stakeholders with weak control over essential resources, that affect the project indirectly or in a low scale (Cziscke, 2018; WRI, 2015).

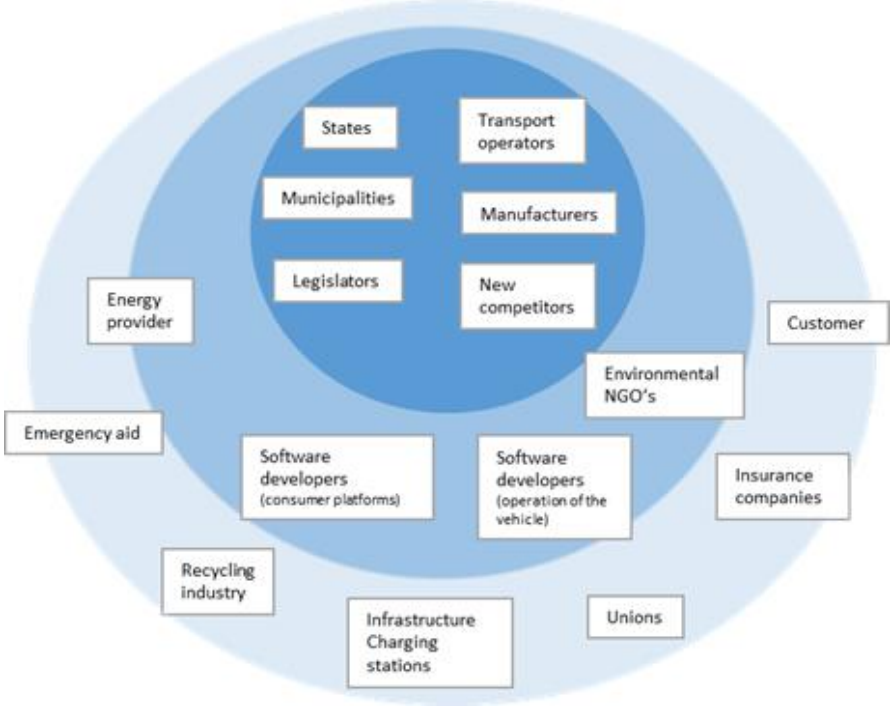

Figure 4: Stakeholders Onion Diagram concerning the implementation of autonomous vehicles in the public transport system

Stakeholders at the primary level are market actors - transport operators, manufacturers, and new competitors - and the government actors - states, municipalities and legislators. As already identified in the graphs before, they are crucial stakeholders with financial, technical and institutional resources to embrace this technology and make the best use of AV's. Moreover, their decisions and actions will definitely shape our future mobility.

On a secondary level, the software providers and energy providers are depicted, providing also important knowledge and resources. Environmental NGO's can be classified in the second level as well, as they are active on the dialogue with multi-stakeholders, in society awareness, and influencing policy makers.

The tertiary level consists of customers, insurance companies, unions, power charging stations, recycling industry and emergency aid. So far, they do not have a direct impact or a strong influence on AV's decision-making and implementation. Some of these actors, such as the insurance companies, are still awaiting more results before setting their strategies (Appendix I: Initial Stakeholder analysis matrix).

2.2.4. Formal network diagram

Lastly, Figure 5: Formal map network diagram shows a formal network diagram. A formal network diagram represents formal relations. These include formal legislation, contractual obligations, and official procedures. These formal relations structure actor interactions and show which actors have the legal authority to promulgate new rules and regulations, or which actors need to approve of specific activities or developments (Hermans and Cunningham, 2018). The formal network diagram depicts two systems: the public transport system and the autonomous vehicle system. These two systems both have its own dialect of control and formal relations. The center forms the AVENUE project, with the mission to integrate autonomous minibuses in the public transport system of European cities.

On the left side, one can observe the main actors present in the public transport system and their relations. Countries are responsible to set regulations, policies and offer financial support. Cities play a role for local road infrastructure and to give the concession for transport operator's services. The transport operators are responsible for daily operations in the cities, as well as they are the 'bridge' between citizens and the new technology tested on mobility.

On the right side, one can observe new emerging actors as manufacturers and software developers investing on AV's development and test. Research institutions shedding light on this topic, are collecting data and presenting valuable insights towards the use of AV's and their potential positive and negative impacts. As mentioned before, EU and legislators are also active in this field and their decision and directives are crucial as well to AV's integration on mobility.

The AVENUE project has the challenging role to test the integration of autonomous minibuses in the public transport system of European cities, and contribute with analysis, results and recommendations learned from this pilot and exciting experience.

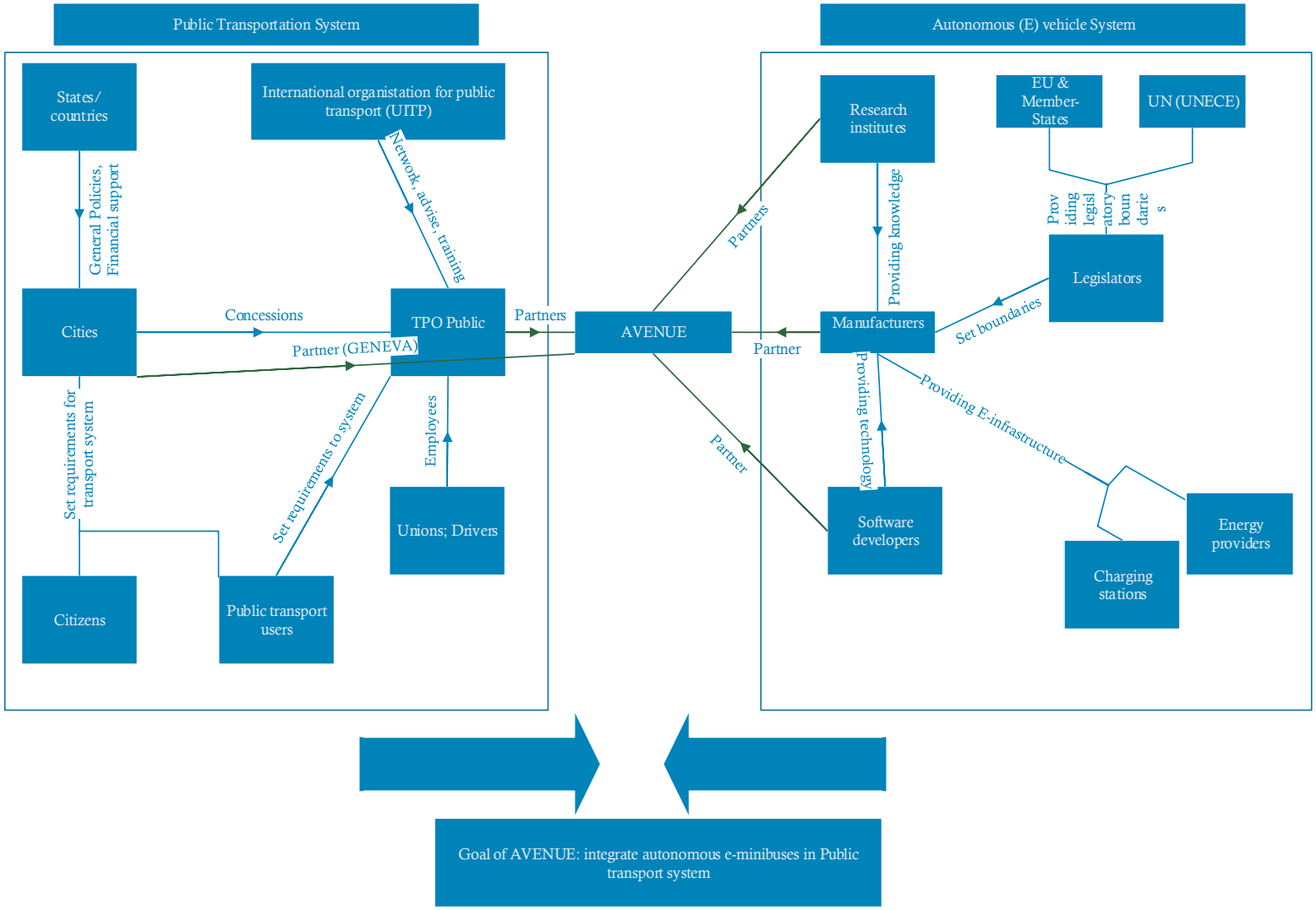

Figure 5: Formal map network diagram

2.3. Selection of stakeholder groups

In the previous section, four analyses based on the characteristics of the stakeholders included, were presented. Based on these analyses, it can be concluded that there is a large group of stakeholders that could be selected for further analysis:

1. Public transport operators;
2. Manufacturers,
3. New competitors,
4. Software developers,
5. States/countries,
6. Local governments/cities,
7. Driver unions,
8. Environmental non-governmental organizations,
9. End-users (customer).

2.4. Stakeholder map based on literature review

The 'AVENUE Stakeholder and mobility services map' (Figure 6: AVENUE Stakeholder and Mobility Services Map) was developed with the purpose of identifying strategic actors, main mobility trends and their interactions in the process of implementation and integration of autonomous vehicles in the transport systems of European cities.

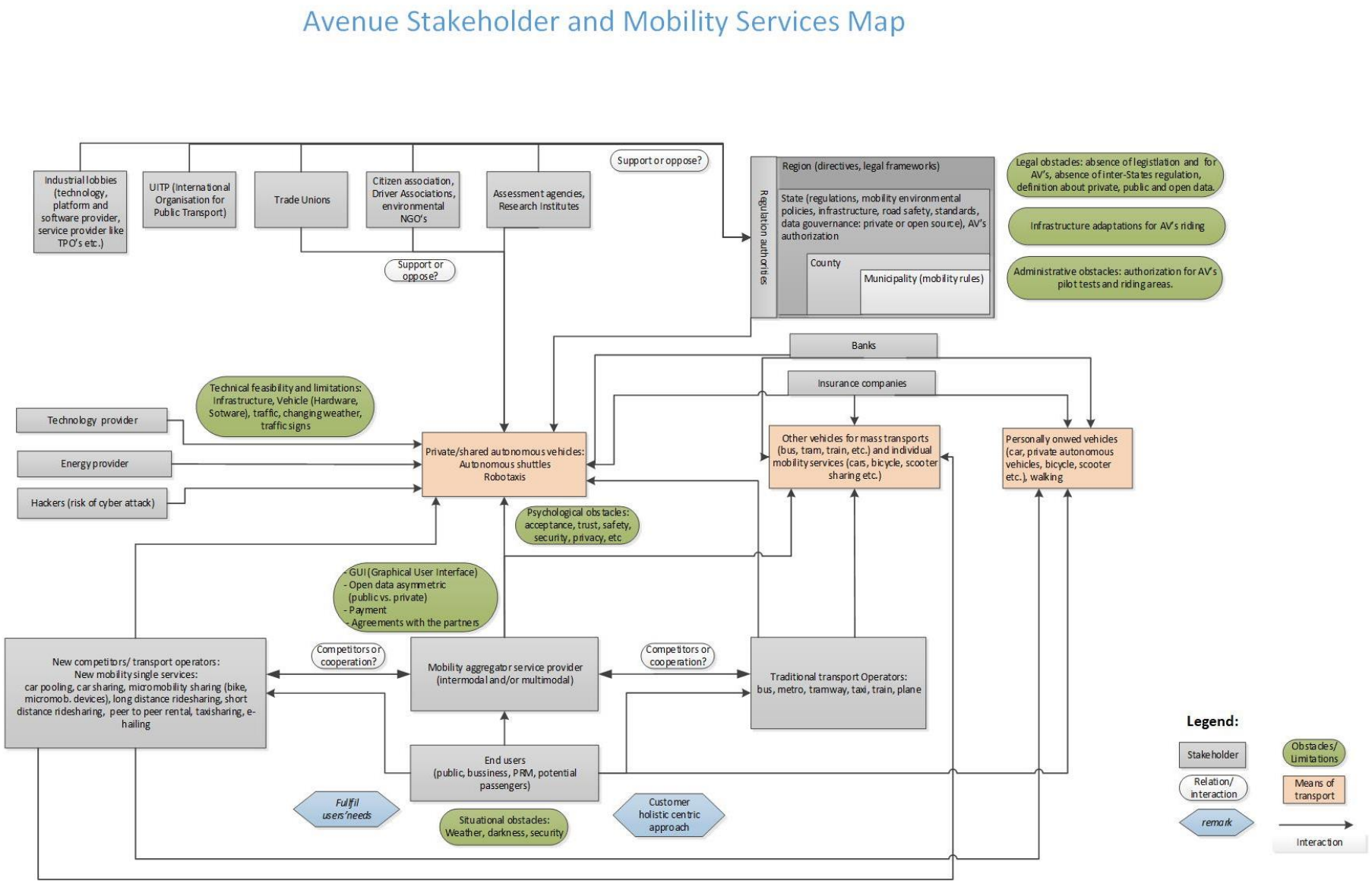

Figure 6: AVENUE Stakeholder and Mobility Services Map

Starting from the bottom part of the graph, the end users are a crucial stakeholder, since it is assumed a customer centric approach on mobility services and the satisfaction of their mobility needs (Fournier, 2017).
The end users have several options regarding the means of transport for short and long journeys in European cities, they can choose:

- Personally owned vehicles (e.g. car, motorcycle, bikes), or walking;
- Public transport offered by traditional transport operators (e.g. bus, metro, tramway, train);
- New mobility services as carpooling, car sharing, micro-mobility services (bike sharing, scooter sharing, etc.);
- Autonomous vehicles emerging as an innovative mean of transport to be integrated in the transport system of cities (Lam, Leung and Chu, 2014; Litman, 2019). It could be a private or shared vehicle, integrated to the public transport system of cities or even to be deployed as Robotaxis.

Thus, taking into account a scenario with multimodal mobility and connected vehicles (Attias, 2017; Fielden and Davidson, 2017), the mobility aggregators/integrators play an important role by providing the Integrated Mobility Platforms (IMPs) as a key solution to simplify the journey planning and payment, and providing highly customer-tailored solutions (Baron et al., 2018). Current main players providing IMPs are for instance Google Maps, Citymapper, Omio, Qixxit, Moovel, among others.

In the upper part of the graph are depicted important and directly involved stakeholders concerning the implementation and integration of autonomous vehicles. On the left side the technology providers and energy providers for the autonomous vehicles, as well as hackers, as an external actor that can present security threats.

Also represented in the map, the insurance companies, despite the uncertainties, consider that initially autonomous vehicles will increase insurance rates due to the fact that they will become more complex and more expensive to fix (Noble, 2018). Later on, it is expected that the insurance prices for autonomous vehicles decrease, considering that the frequency of claims might reduce and the percentage of autonomous vehicles on the roads might increase (Noble, 2018).

In addition, when addressing autonomous vehicle technology, potential new insurance market fields are pointed for the insurance industry, such as Cyber Risk, Software and Hardware, and Infrastructure (Costonis and Kim, 2017).

From the bank perspective, autonomous vehicle technology can trigger significant changes on financial services. Therefore, banks should embrace the changes and new technologies (e.g. artificial intelligence, blockchain, distributed ledger technology) and re-think financial services according to these new technologies (e.g. IoT, sensors, connected cars) (Pinto, 2018; Hadar, 2018). Important transformations mentioned by Pinto (2018) are:

- The sharing economy and the changes on how banks model their financial services, considering the shift from ownership to sharing-based models;
- Open banking and the changes on how users will do their payments, loans, credits, risks;
- Security concerning privacy and hacking cars;
- Customer trust.

In the upper left side of the figure are represented the transport organizations (e.g. Union Internationale des Transports Publics - UITP, International Road Transport Union - IRU). The trade/driver unions (e.g. United Road Transport Union - URTU in UK, le syndicat du transport - ST in France). The assessment agencies (e.g. Centre Européen d'Études de Sécurité et d'Analyse des Risques - CEESAR), NGO's, research institutes and industrial lobbies actors that can have a support or opposing positioning concerning autonomous driving and the different ways for implementation.

In the upper right side is illustrated the multi-level structure considering regulations authorities and governance levels. They play an important role by addressing the regulations, policies, economic incentives, data governance and infrastructure for autonomous driving. Such actors are strategic in order to model, plan and implement the appropriate integration of autonomous driving on the public roads (Attias and Mira-Bonnardel, 2017; Glus, Rothman and Iacobucci, 2017).

For instance, policies and economic incentives can affect in the user preferences for sharing or private use of AV's.

Thereafter, Figure 7: AVENUE Stakeholder Map and Mobility Trends presents the 'AVENUE Stakeholder Map and Mobility Trends' with the purpose to shed light on current trends shaping the future of transport. For instance, the debate regarding mobility and open data, the role of the mobility aggregator/integrator, and the pursuit to lead the offer of Integrated Mobility Platforms for end customers. The figure illustrates as well main actors concerning the autonomous vehicles ecosystem.

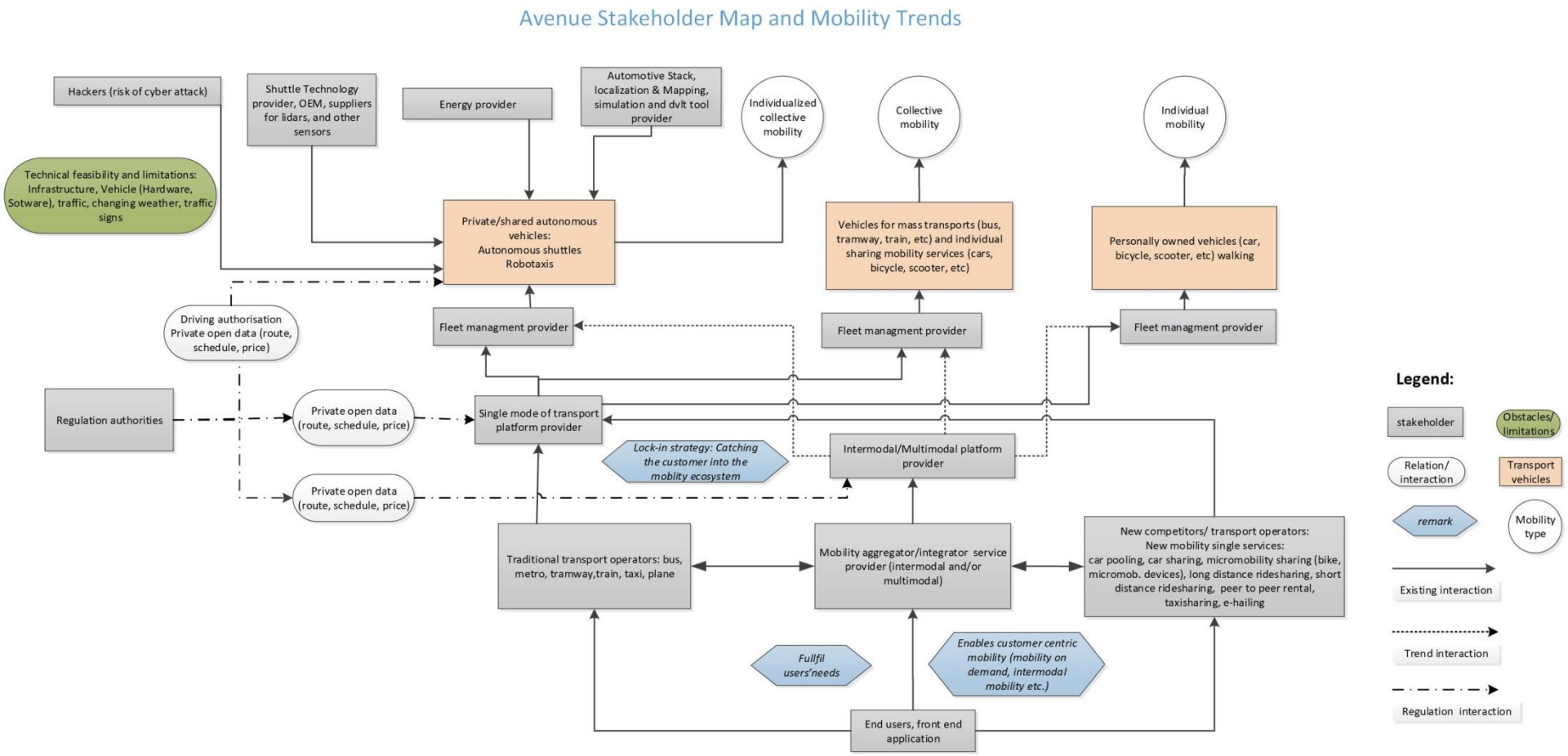

Figure 7: AVENUE Stakeholder Map and Mobility Trends

As discussed previously, end users have access to diverse and different means of transport in European cities. Nonetheless, frequently they face problems to easily plan and pay their journey using one single platform. Consequently, end users have to juggle among different mobility platforms to plan multimodal journeys (Steinmann, 2018).

In this regard, the mobility aggregators/integrators have developed Integrated Mobility Platforms (IMPs) aiming to win the customers by fulfilling this gap and simplifying the route planning and the travelling experience (Baron et al., 2018).

However, the encouragement of the emergence of platforms, that would centralize all mobility services offered in one region, involves strategic decisions and regulations regarding mobility open data (Steinmann, 2018).

From the State and local mobility authorities' perspective, enlarging the mobility open data would contribute to have a better overview of the transport flows and especially the private mobility flows in cities, allowing them to adapt public provision according to the customer needs (Hassini, 2018).

Although, the discussions around the mandatory opening of mobility data, without distinction between private and public, present discontents and uncertainties for both sides: mobility companies and public transport operators.

On the one hand, mobility companies (e.g. Waze, Uber) agree to cooperate with information for local authorities to improve their transport supply, nevertheless, they express the concern that opening access to anyone poses a competitive problem (Hassani, 2018).

On the other hand, the open data legislation can also be critical for public transport operators, once they fear that it would facilitate the hegemony of non-European digital giants (e.g. Google, Uber, Apple) (Mallet, 2019). For instance, operators consider the risk of being deprived of contact with the customer, including the ticket selling, in favor of the "integrators" and their Integrated Mobility Platforms (Julien, 2019).

Hence, the mobility open data regulation is a current strategic topic for private and public actors to plan their next steps.

Following, the upper left of the figure depicts the AV ecosystem, composed by:

- Original Equipment Manufacturers (OEM): companies actively developing AVs as private vehicles or fleet-based operation as ride sharing platforms, Robotaxis or shuttles (e.g.: Navya, Easymile, 2getthere, Olli) (VSI Labs, 2019);
- AV's Hardware: companies that provide sensors to read the environment (lidar, cameras, radars, etc.), compute solutions, on-board communication products, and V2X solutions to communicate with the environment (vehicle to vehicle - V2V, vehicle to infrastructure - V2I, vehicle to devices - V2D) (Amblard, 2018);
- AV's Software: companies that develop the stack for vehicles, localization and mapping solutions, simulation and validation tools and contents, and development tools (Amblard, 2018). Examples of big companies investing in full stack are Waymo, Uber, Apple, Lyft;
- Energy providers;
- Hackers, external agents that present the risk of cyber attacks.

3. Longitudinal stakeholder analysis

Following, the empirical interview-based research is interpreted in a longitudinal manner. Each stakeholder group is presented and described according to its objectives, self-perception, interest, attitudes and opinions towards autonomous driving, current and foreseen obstacles, offered solutions, the Organizations' resources, and perception of other stakeholders. Ultimately, the Stakeholder Map is presented as a graph representation from each stakeholder ecosystem.

3.1. Public Transport operators

The Public Transport Operators (PTO's) are responsible to provide the public transport services in cities. Upon a previous report, this group has already been described and the Stakeholder Map has been presented. Therefore, in this section, a brief reprise on this target group addresses its main topics.

3.1.1. Strategic objective / Self-perception

"I generally think, we're gonna have a better world once the autonomous vehicles are fully implemented in a lot of different perspectives." (Interview with PTO). Interviewees stressed the strong need to be competitive in the future. From their personal and from their company's perspective, interviewees expect autonomous public transportation to contribute to societal benefits such as better quality of life and improved health and environmental conditions due to reduced pollution.

PTO's perceive autonomous vehicles as a "key topic for the future" and as a decisive element of competition. In addition to the traditional transport system, autonomous vehicles are currently developed by public transport operators.

3.1.2. Interest / attitude

Concerning the PTO's attitudes towards autonomous vehicles, a distinction was made between two groups: one group is dedicated to the sole task of developing autonomous shuttle systems. The second group, which has a more common perspective, primarily develops the operation of traditional public transport systems in conjunction with pilot projects on autonomous shuttle systems.

3.1.3. Obstacles and challenges

"We will not reach level 5 within the time-frame of the AVENUE project" (Interview with stakeholder PTO). PTO's have pointed out main obstacles that were grouped into four categories:

- Technological challenges: due to the fact that PTO's depend on manufacturers for technological developments, in this sense, they are limited by the path of technology improvements on autonomous driving. In addition, another obstacle is the infrastructure adaptation to receive this new technology.
- Social acceptance (by users and employees): PTO's raised questions related to how would be the user's acceptance towards this new technology and services, as well as the safety/trust feeling. The bus driver's acceptance is seen as a potential challenge due to job losses. On this issue, the operators consider as a solution to provide training aiming a job transition and functions related to autonomous buses operations.
  Furthermore, the social acceptance has been distinguished further for two groups of clients: the end user acceptance and willingness to pay is still unclear. Additionally, the (local) governments and grant concessions prescribe the modal split and preferred the sharing of the public transport system and setting requirements for the scope and quality of the public transport system within their administrative boundaries.

- Regulatory framework (i.e. legal system, i.e. administrative): legislations need to be adapted to allow autonomous vehicles to operate on public roads. In addition, the bureaucratic efforts to receive the required permission for the pilot project can present barriers and it can be a demanding process.
- Business models: currently, the autonomous shuttles have an operator on board, and the operator costs has significant impacts on the business model feasibility, as they represent up to 50% of the costs of the system. A second challenge concerns the high costs for the shuttles in combination with the required technology and infrastructure modifications. Competitiveness will be reached under the assumption of a rapid decrease of such costs in the future. With on-demand-services, PTO's might face competition from taxi services and other autonomous private shuttles and vehicle-sharing systems.

3.1.4. Offered solution

The offered solutions had a focus on the end-users, therefore, aiming at a successful implementation, and PTO's have highlighted that the transport system should fulfill the users' needs and provide additional services (e.g.: comfort, on-demand services, night-time services and up-to-date information). Three aspects are important for autonomous shuttle systems to be successful: users should accept the technology; have trust in the system's safety; and should perceive additional value (e.g. increase flexibility, reduce travel time).

Furthermore, an important role for the transport operators is to manage the expectations of the users. A challenge concerns the fact that the system is not as advanced as users expect. Namely, the speed of the buses is significantly lower than normal buses (max. 25 km/h). Even though, there is no driver on board of the shuttle, there is still an operator on board.

3.1.5. Resources

With regard to the topic of autonomous driving, PTO's are the link between the users of the transport system and developers of the system. These actors have the interest and power to implement in practice autonomous driving in the public transport of cities.

The majority of the PTO's that were interviewed have already a well-known and well consolidated service in the cities' transport sector. Hence, they can take advantage of a broad network and reputation.

3.1.6. Perceptions of other stakeholders

As stated previously, end-users are a key group when it comes to social acceptance and a successful implementation. In addition, the interviewees have mentioned governmental actors, politicians, and manufacturers.

The perception on governmental stakeholders gives a very pluralistic view. Authorities, legislators, and municipalities can present a positive and supportive attitude when putting autonomous shuttle systems in place. Nonetheless, administrative issues and regulation might become barriers for implementing autonomous shuttle services.

The manufactures have a crucial role as they provide the technology. Currently, the technology is determining and limiting the services offers.

3.1.7. Stakeholder map

The stakeholder map was illustrated based on inputs from the interviews conducted with the PTO's. Hence, it presents a 'bottom up' perspective, with specific interactions and stakeholder ecosystem

characteristic to this target group. The stakeholder map will be refined and adapted throughout next phases of AVENUE task 2.3.

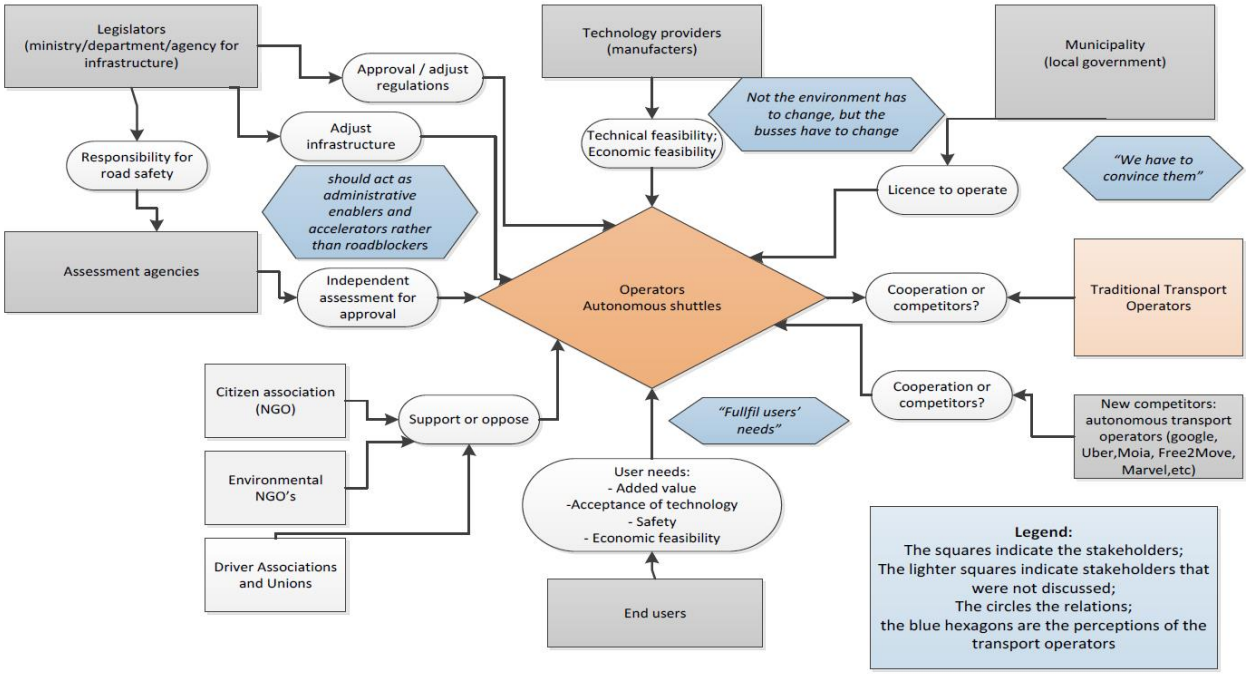

Figure 8: Stakeholder map from transport operators' perspective

3.2. Manufacturers

Manufacturers of autonomous minibuses are important stakeholders. Navya, the manufacturer of the shuttles in the AVENUE project, has as primary goals offering of new mobility solutions, establishment of a good market position, consumer confidence and acceptance. In order to do so, they focus on implementing their products in public systems as soon as possible. Well-drafted standards can increase the rate of development and reduce overall system cost per vehicle. Navya, being one of the strongest competitors due to their high technology-development and rising more than €30 million euros in 2018 makes them an important and attractive stakeholder for the AVENUE project. Other manufacturers have similar goals and are as crucial for a successful implementation of the system.

3.2.1. Strategic objective / Self-perception: Responsibilities and self-conception

From the conducted interviews, a homogeneous picture emerges from the group of manufacturers of autonomous minibuses. The manufacturers all have similar ideas of what future mobility should look like and pursue a similar strategy. According to the United Nations, increasing urbanization, with two out of three people living in cities by 2050 and the associated increase in traffic in conurbations, requires innovative, sustainable concepts in the areas of transport, infrastructure, and urban planning. The manufacturers are aware of this challenge and would like to make a targeted contribution with their products in order to counter these future developments in the field of mobility and to be part of the solution.

The autonomous minibuses are currently implemented in pilot projects all over the world to learn more about the requirements of the environment and their use in various practical scenarios. Therefore, there is still a need to further develop and optimize the products and to extend them to other areas of application. Nevertheless, the manufacturers are convinced that with their vision of autonomous driving in public transport and on short distances, they have developed a concept for the future that will transform traffic in cities in the future with the properties of autonomous, shared, connected, and electrically driven vehicles.

“One of our aim is really redefining the traffic flow in your city through giving a new mobility offer which complete transfers network system. (…) And for that, we have developed several kinds of mobility solutions, all autonomous, electric, and shared.” (Interview with stakeholder 3, 11 July 2019). The aim of the companies is to improve the service on the first and last mile, to be a new alternative for the transport of short distances, to establish the technology on the market and to serve a new business model. The manufacturers also agree that future mobility will be partly autonomous and partly manual. This means, for example, that there will no longer be any drivers "on board", i.e. the vehicles will be fully automated. The drive should be electric, thus sustainable and emission-free, in order not to pollute the air of the cities any further and to find social acceptance. *“Technically, using a combustion engine rather than an alternative propulsion system, it doesn´t matter. For social acceptance, you need it to be electric.”* (Interview with stakeholder 5, 24 June 2019). One primary goal is that the people use more public transport services and to focus less on individual mobility. It is therefore intended to initiate a process of change in society, as we want to be mobile in the future.

As an integral part of public transport, vehicles are to be used by people in cities and in certain areas as fleets. With their vehicles, manufacturers want to play an active role in shaping the future of mobility and drive this new technology.

3.2.2. Interest / attitude

The manufacturers that have been interviewed stated the goal to do pioneer work with their product and to bring the technology of autonomous driving into the everyday life of people and public transport. They have developed a product with which companies want to establish a new technology that offers society added value in terms of the environment and sustainability, in addition to the classic goals of entrepreneurial success. With their product, they are opening a new solution for an existing market in which they want to establish themselves alongside providers of classic mobility solutions and expand into new markets in the future. The added value that companies want to offer society is an increase in mobility.

As these are shared services, the traffic volume will not be further increased. Furthermore, less space in cities will have to be reserved for parking facilities and thus areas will be usable elsewhere for city dwellers, which will lead to a general increase in the quality of life in cities. Another important social aspect is the higher safety of autonomously operated vehicles, as fewer traffic accidents are expected. To achieve these goals, changing people's mindset in mobility is important. In the interviews, the companies named three main areas as obstacles. Companies see major challenges in the acceptance of the new technology by society. In addition, the legal framework has yet to be created by the legislators. Finally, research and development is very cost-intensive for manufacturers. Since the market is still manageable and the application possibilities are limited, the market is still growing slowly. Manufacturers are therefore dependent on public or private partners.

3.2.3. Offered solution

The providers of autonomous minibuses want to close a gap in the mobility market with their product. On the one hand, they offer a product that is particularly suitable for use on limited areas such as airports, hospitals, military bases, university campuses or in gated communities. Here the traffic situation is less complex, and no high speeds are required. Another possible application is for first and last mile operations. In the future, after a longer journey by train or car, the last mile to an office or shopping center will be covered by an autonomous minibus. For example, such a scenario could look like this: a businessman takes the train to a central station from where he gets on an autonomous minibus that takes him to his office on the so-called "last mile". In such a scenario, the rail operator could also be the operator of an autonomous minibus fleet and offer this to his customers as a further service. Its use in local public transport in cities is currently being tested and is set to become an integral part of urban passenger transport in the future. The autonomous minibuses are emission-free and low-noise and, thanks to gentle navigation, safer than conventional means of transport for groups of up to 15-20 people. The roads in the urban centers' will also be relieved and the density of traffic reduced.

3.2.4. Resources

The companies representing this stakeholder group are still young and are growing, therefore they have a high capital requirement. In order to continue to grow constantly and to finance the costs of research and development, they need investors or government subsidies. Another important factor is technological expertise, for example in software development, acquired through cooperation or partnerships. Several manufacturers have strategic partnerships with industrial groups, which support them financially and with know-how. Finding such cooperation partners and maintaining the cooperation is essential in order to be able to expand further. The hiring of specialists or further training of own employees to experts is also an important component to have competences in the own company.

3.2.5. Perceptions of other stakeholders

From the discussions with the manufacturers, four groups can be identified that play a superior role in the network. Through their special function, the stakeholders influence the framework conditions, in which the manufacturers operate, as well as the technology and material used in the vehicles, in a variety of ways. Probably the most influential group is the government. It has several authorities, including the public transport authorities, which have tools that can significantly enhance or even ignore the success of

manufacturers and the breakthrough of technology. Public transport operators for example define traffic rules, which manufacturers must take into account as requirements in their products. Suppliers and technological partnerships are another important network partner. They supply the manufacturers with materials and the necessary components as well as with a variety of software that every autonomous vehicle needs. Furthermore, strategic partnerships are of great importance for manufacturers, for example in order to achieve synergies in research and development and not to solve everything on their own. Both sides profit from this cooperation. Last but not least, the customers have a great influence on the product. They influence the market price and specify functionality. It is important for manufacturers to pay close attention to the needs of customers, such as public transport operators, in order to ensure that their vehicles do not miss out the market. It will therefore continue to be important for manufacturers to work the mobility market and convince the public, which will be the users of the innovation. The decisive factor will be that the manufacturers will be able to serve the market when the technology breaks through.

3.2.6. Stakeholder map

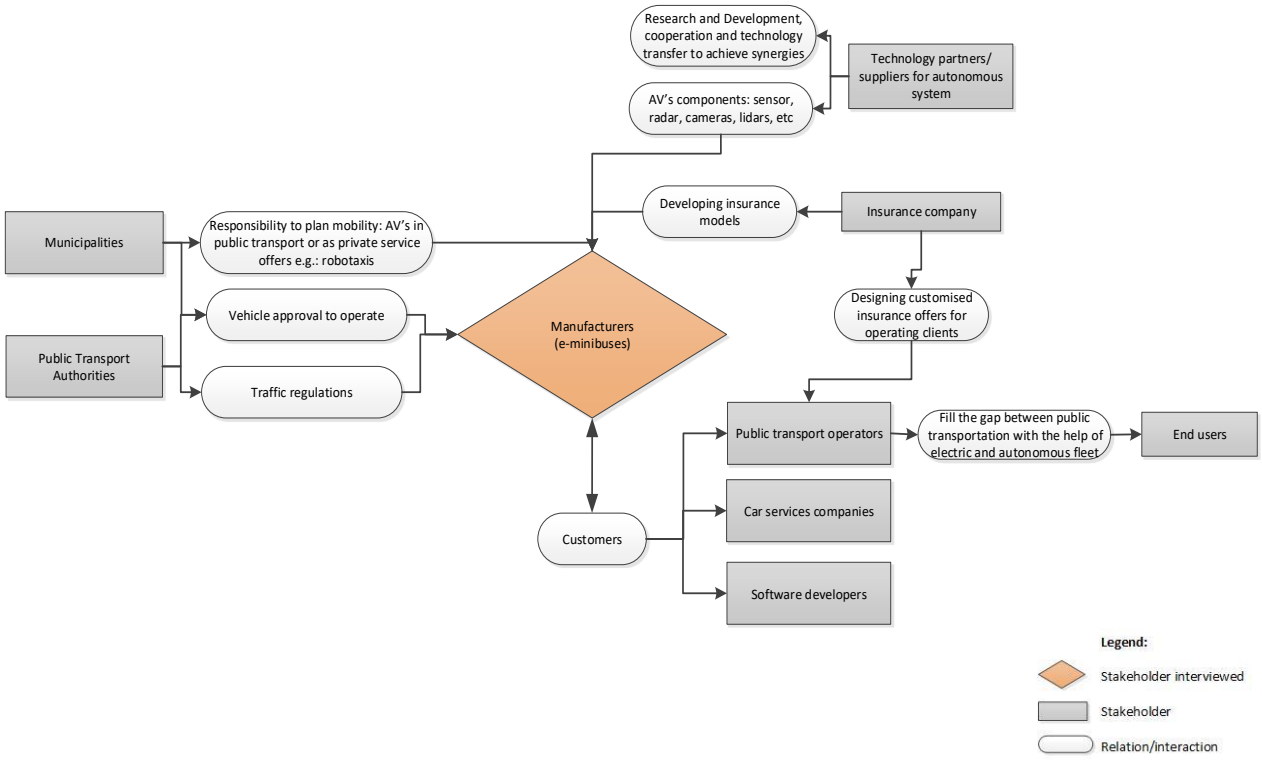

Figure 9: Stakeholder map from manufacturers' perspective

3.3. Software providers

Software providers offer platforms that enable intelligent operation and optimization of autonomous mobility services, managing fixed-route and on-demand services. These cloud-based platforms are crucial for the system to function. Furthermore, the platform should also function as the interface between vehicles, travelers and mobility providers. Software providers are crucial stakeholders, as an autonomous system cannot work without a proper software platform. *"We take the vehicles from the others and we equip that with our software and the sensors and make highly automated project together with a company. (…). Our focus is different, because we have a software and we can provide whatever vehicle and we have as well a fleet management in the background. So, it means that the fleet management of large fleets is one of the aims (…)."* (Interview with stakeholder 2, 26 June 2019)

3.3.1. Strategic objective / Self-perception: Responsibilities and self-conception

"The goal is (…) to equip as many different vehicle types in different environments and scenarios with our technology and to learn basically from the environment (…)." (Interview with stakeholder 2, 26 June 2019). The aim of software developers is to offer their services to the greatest number of vehicles possible. Therefore, partnerships with government or big fleet managers are crucial to its survival. Making alliances with other entities boosts the development of technologies used in driverless programs. Deploying autonomous vehicles with technology that reduces accidents, limits time wasting due to traffic jam, and simply ease the movement around cities are common objectives mentioned by interviewed experts. All software developers assure that when their system is deployed on cities, this will have a huge impact on saving lives. There are numerous investigations supporting that car accidents are majorly attributed to human errors either because distractions or health limitations. Autonomous driving programs are not susceptible to exhaustion, health problems or lack of focus like humans do. Thus, software developers are committed to deliver an impeccable set of algorithms and codes that overall assures user security.

Another common strategic objective of software developers is to change the mindset people have regarding mobility systems. Changing transportation time to a more productive use of time, which can be used for activities that add value to personal life, is an additional objective of the software providers. In order to do so, it is of high importance to have a trustful system that enables users to forget the road and take advantage of the potential time. As stated by interviewees, once fully automated systems are implemented in daily life, the interactive open space offered by the transportation system can be used to plan next day`s activities, make reservation for today`s dinner, check weather channel, review important news, etc..

The main objectives and responsibilities of software manufactures are clear: assure safety, efficiency and punctuality for end users.

3.3.2. Interest / attitude

During the interviews with experts in the field, it became clear, that software developers have a very positive attitude towards autonomous driving. As previously mentioned, autonomous vehicles will be operating on many streets worldwide. Therefore, a very specific and detailed program that limits possible failures is of great importance to any manufacturer, service provider or fleet manager. Due to the fact that nowadays most of the potential errors regarding autonomous driving could be attributed to system failure, software developers take the perfection of their programs very serious, in harmony with all hardware instruments.

Interviewed experts testify that social acceptance is very positive among all ages, nationalities and gender. Even back to projects launched in the early 2000's, when technology was not as mature as nowadays,

autonomous driving has been perceived as a sceptic idea, but positive by society. Nowadays, with even more and new autonomous projects, the integration of autonomous shuttles or cars running in various countries, society just wonders and awaits the day that this technology will be part of their daily life.

At this moment, there are some technological barriers that software manufacturers will face. Interviewees stated that due to a lack of technology options (depending in few suppliers) and excessive prices of components, the development is hindered. Additionally, autonomous vehicles are not yet permitted to run on every street, even though global technology is moving forward at high speed. In order to have the software applied in the most effective way, software manufacturers rely on few suppliers that offer the needed components for the optimal execution of their programs. This causes an increment in cost because of low supplier market competition and limited technology portfolio. As time goes by, new technology and new competitive suppliers will enter the market, generating new opportunities to lower costs. The development of the autonomous driving market will enable even more opportunities for software developers to deploy their operative system in different scenarios resolving ongoing challenges.

3.3.3. Offered solution

"We really focus on shared and poolling. That´s the strength of our IP and how to serve more people with less vehicles." (Interview with stakeholder 4, 4 July 2019). The interviewed experts perceive the future of mobility to be shared and driverless. Until recently, autonomous driving is providing service for the first and last mile drive. The first mile is defined as providing the connection from the initial location to the train station, bus terminal, metro entrance, airport or other functional mobility services. Users can be independent from private cars or congested public transport. On the other hand, the last mile is the service that connects train station, bus terminal, metro entrance, airport or other functional mobility services to final destination. For the future, interviewees stressed that autonomous driving would be part of the complete mobility chain. At the moment, first and last mile service offers are the first steps towards a completely autonomous service. In order to do so, technology must be perfected and achieve its maximum maturity. As time goes on, autonomous driving will be more accessible in both economic and technological terms. In a next step, software developers then can offer complete services to existing mobility companies, governments or fleet managers.

Software developers offer solutions for transport systems creating a direct connection from existing networks and new possible routes or on-demand services. Some interviewees have access to public operator schedules, live locations, peak hours, and congested areas, among others. Additionally, software providers are cooperating in common projects with public operators to connect business models, long distances and first- or last mile services.

Software operators are constantly looking for entrance in operative systems of real public transport operators. Therefore, future solutions of software developers do not consider fleet operators as competitors or the other way around, but rather as a potential future partner.

3.3.4. Resources

For software developers their information source is the core of their business and therefore it is particularly confidential. Pioneering new technology in the field of digitalization with new projects and many emerging competitors makes data the most valuable good the stakeholders possess. As it is nearly impossible to find open and public data, software developers generate data and information in own pilot tests. For software developers, it is crucial to confidentially handle their pilot test information. Otherwise, their business model can be threatened by new competitors or the loss of customer's trust if they don´t handle information confidentially. Nowadays, all developers experience on their private runs and gather information for the implementation and for software update. As previously mentioned, software developers build relationships with existing mobility services in order to extract as much information as

possible. Next, this information is processed in order to come up with an optimal solution for an existing gap.
For example, if a bus operator in a city would share traffic and congestion data from certain area and real time information with software operators, they could update the algorithms of autonomous vehicles to allocate a better traffic flow. Merging this information could help solving autonomous driving's goal of providing a useful and practical mobility service.

3.3.5. Perceptions of other stakeholders

Software developers count on numerous stakeholders due to the fact that many actors are involved at the moment for developing a program that is capable of transporting people. There are plenty of organizations involved, one example being end users. Users normally will not pay much attention on the brand of the autonomous vehicle, but they will pay more attention on the company that is operating the vehicle. When autonomous minibuses are fully deployed in various cities and involved in an accident, a lot of people will hear about it. As a consequence, they may avoid services offered by the developer or company that managed the bus. End users are the ones that choose the services. Therefore, a trustworthy and reliable image and flawless execution is required from developers' side.

Another very important stakeholder for software developers are local governments or municipalities. Without permission and proper relationship, software developers and mobility companies will have a hard time trying to deploy services in those cities. Interviewed software developers state that governments have been, for the moment, very accessible and open to this avant-garde technology. Another crucial stakeholder for software developers are fleet operators and mobility companies. These ones merge the software with their own vehicles and business model. Fleet operators take the decision of where to set routes, how many vehicles should be operating, how long are operating hours or even how long the lifetime of vehicles is. Thus, it is vital for software developers to maintain proper relationships with these stakeholders.

As previously mentioned, depending on few suppliers is a severe problem that software developers face. If a public operator applies the software offered by the stakeholder in their buses in combination with low quality radars, sensors or cameras, the software will not be likely to produce the outcome that was initially planned. On the contrary, if the fleet management decides to deploy the software in combination with high quality components, the price of such components will be high, and these parts will be available from only few suppliers. Obviously, the quality of the product that software developers offer depends not only on their own ability to develop a proper product, but also on their clients' willingness to pay for their products. Therefore, it is very important for software developers to secure both, technical assurance and proper functionality of components for optimal performance.

Another important stakeholder for software developers are fleet management organizations. They both have the same objectives and work together to ensure a maximum level of success. Their most important objective is safety assurance. Additionally, fleet management strives for flexibility, punctuality and functionality, which are crucial objectives. In order to achieve this, software developers must constantly work in harmony with fleet managers.

3.3.6. Stakeholder map

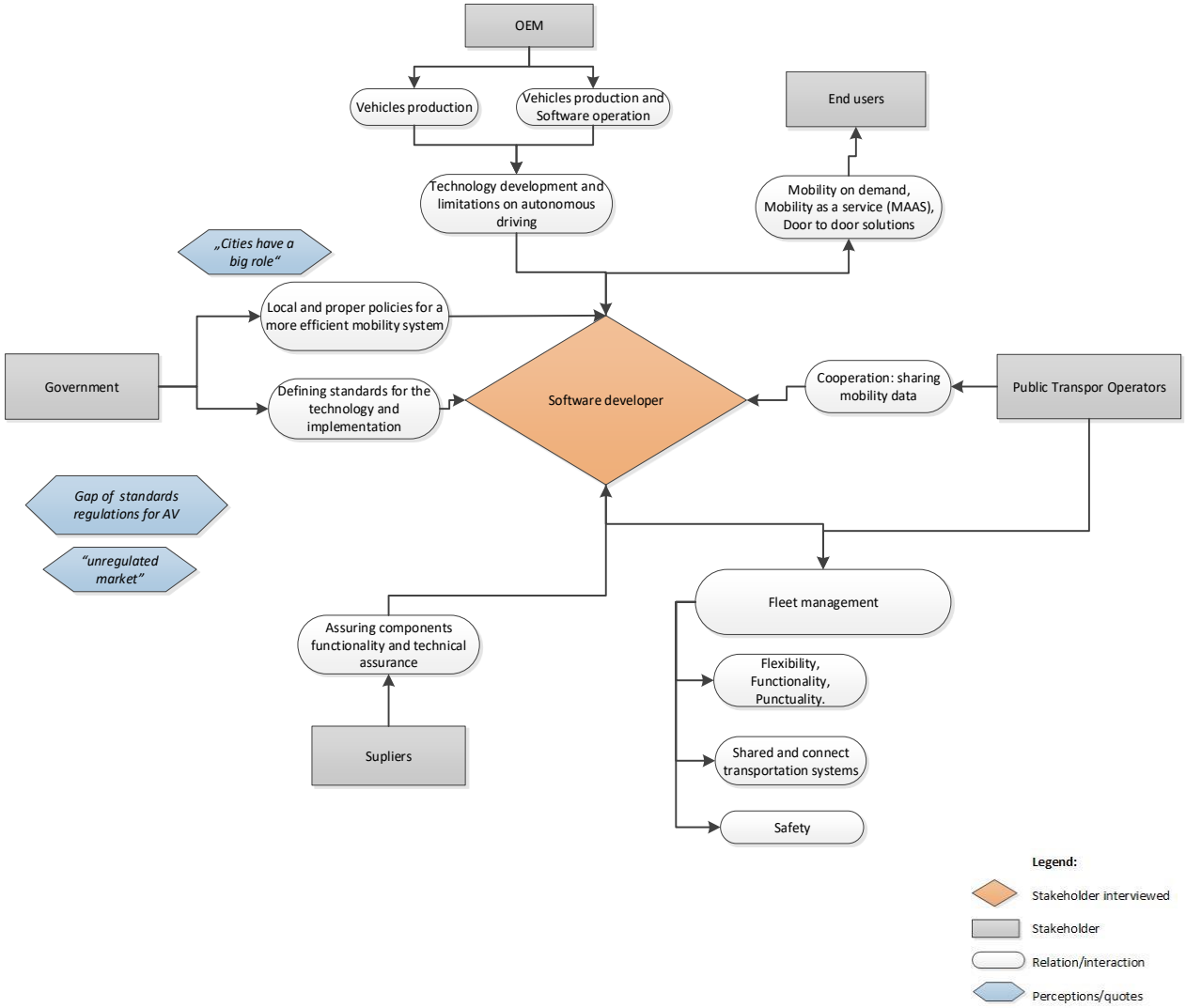

Figure 10: Stakeholder map from software developers' perspective

3.4. Driver unions

Bus drivers, bus-trailer drivers, taxi drivers, truck drivers and all kind of land transport operators are supported and guided by associations that, among others, help them having better job conditions. Driver unions address topics like the drivers' re-education and formation for work, better road conditions, safety assurance, agreements with employers' organizations and governments.

3.4.1. Strategic objective / Self-perception: Responsibilities and self-conception

The interviewed driver unions are well consolidated organizations, with many years of experience, significant number of members, and with local, national and international networks.

One of their primary actions is to be part of the dialogues in the transport sector and to negotiate collective agreements for their members. As stated: "*We have a lot of willingness to negotiate, bargain, make agreements and compromises and bring the work organizations together*" (Interview with stakeholder 11, 19 August 2019).

In addition, priority actions address improving the drivers' working conditions, e.g.: better services along the roads (proper places for the mandatory resting time, restaurants, showers, toilets), parking, safety conditions and common road signs in European countries.

The interviewed driver unions had as well highlighted the strategic importance and their focus on professional education, informing and training, as quoted "*for us is more about re-educating people … there will be a big need for skilled workers*" (Interview with stakeholder 11, 19 August 2019).

Another interesting factor to mention is the fact that interviewees in general stated that in the short and medium term there will be a lack of drivers. Hence, besides the efforts to promote trainings and more skilled workers, driver unions aim as well to improve the job opportunities, to offer good positions, and to make the driver work more attractive.

3.4.2. Interest / attitude

Based on our interviews, driver unions are aware about autonomous driving, nonetheless, this is not a priority issue. And so far, they do not see it as a threat. Interviewees recognize that the development of autonomous driving and autonomous vehicles is in progress, but not part of the near future. And it can contribute to better job positions, the need for more skilled drivers and consequently, better salaries.

However, they point important barriers, for instance, drivers can drive on roads in very challenging situations, as the ones found in northern countries. Roadways can become difficult to drive on because of low visibility due to fog, snow, low signaling or other challenging weather conditions. As explained by one of the interviewees, on some rides on iced highways, the tiniest shift exponentiates the movement of the vehicle, causing a potential accident due to lack of vehicle's control. Therefore, from the perspective of one interviewee, the experience that bus driver gets over the years is very difficult to overcome via autonomous driving, hence "*drivers will be always needed*" (Interview with stakeholder 6, 08 July 2019).

More general barriers comprehend cyber security issues, fear of hacking, and social acceptance. Concerning autonomous vehicles, one of the interviewees has stated: "*So far, no one is really scared about it. We are more scared, when a company like Uber uses digital platforms to disrupt the taxi industry and the workplaces by offering passengers/costumers very cheap transportation without paying taxes, without paying decent wages for the drivers.*" (Interview with stakeholder 11, 19 August 2019).

3.4.3. Offered solution

"*Our work and most important role is to create or being part of the discussion before all changes have been completely disruptive for the sector*" (Interview with stakeholder 11, 19 August 2019). Dialogue, agreements, information and education of their workers for job transition, job rotation models are part of their strategy and solutions for the dynamic changes in the transport sector. Furthermore, initiatives to improve work conditions and the prestige of drivers' profession, in addition to the communications and media, are also undertaken.

3.4.4. Resources

The interviewed driver unions stated the creation of a solid network along the years, establishing dialogues and partnerships with companies, government and their members. Their network reach the local, national and international scales.

Their institutional resources vary, whereas some driver unions have very active members, others are missing human resources. Moreover, their financial resources are pointed as limited in general. When compared to companies, driver unions do not have enough financial resources to hire experts, for lobbying, and to work on public opinion reports.

3.4.5. Perceptions of other stakeholders

Driver unions are in constant dialogue with multiple levels in the government and companies in order to represent their members and their interests. The international and European levels are also strategic to achieve common agreements on infrastructure and road signs. Driver unions are active by offering legal advices, education and information for their members, and representing them when negotiating for better work conditions. One of the interviewees stated the importance to be active as well on the media, by providing interviews and giving visibility to their ideas and initiatives. Universities are also partners and a source of information and exchange with experts.

3.4.6. Stakeholder map

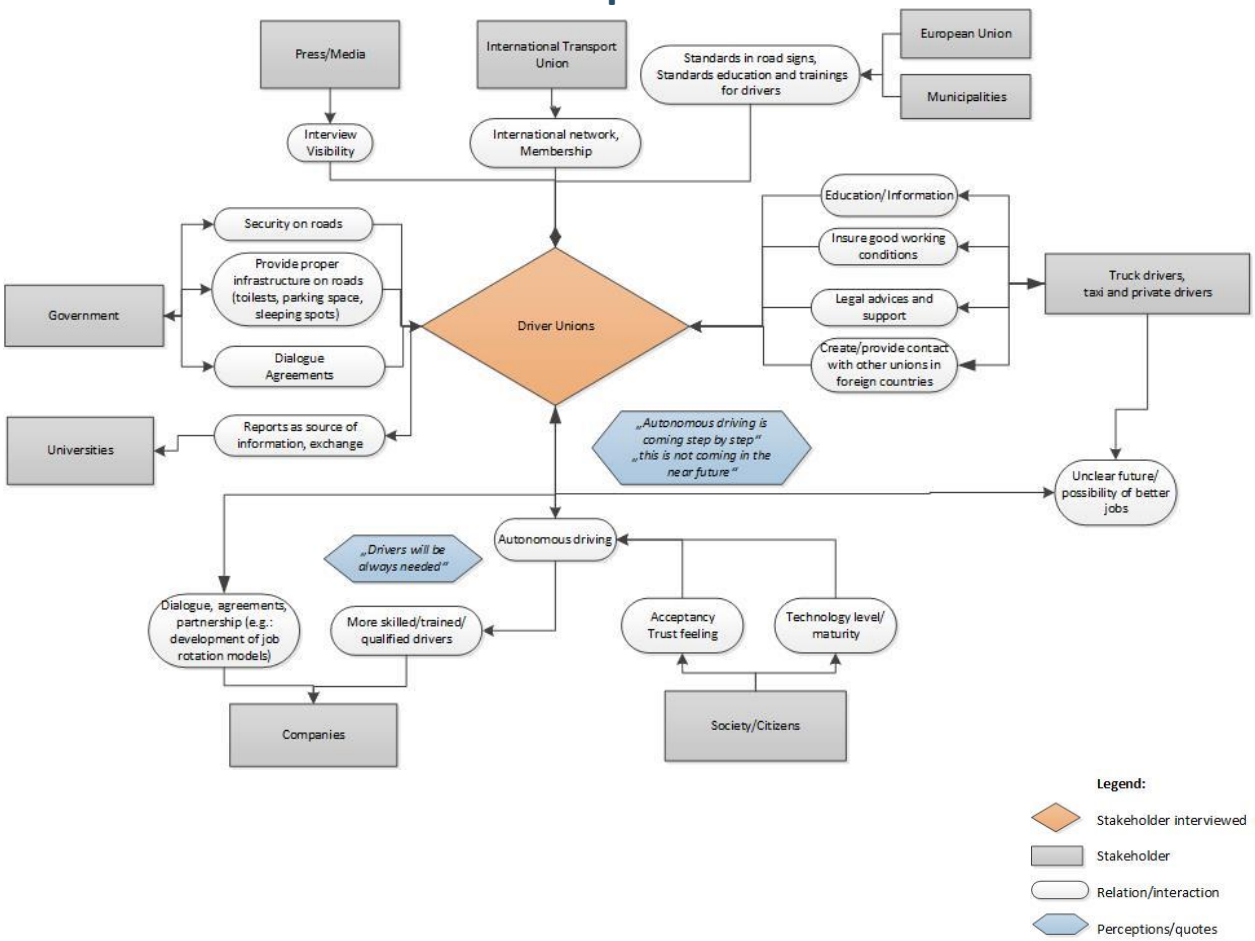

Figure 11: Stakeholder map from driver unions' perspective

3.5. Environmental NGOs

3.5.1. Strategic objective / Self-perception: Responsibilities and self-conception

It is not a surprising fact anymore, that the mobility system has been disrupted by three major revolutions: automation, electrification and approaching a shared system (Dawn Spewling) (Interview with stakeholder 10, 19 June 2019). As most interviewed NGOs, they aim for an efficient development of the future mobility system, emitting as less GHG (greenhouse gas) emissions as possible. The stated revolutions are perceived as both, options and threats by these organizations (Interview with stakeholder 10, 19 June 2019. Interview with stakeholder 8, 17 June 2019). While a sustainable development of public transport seems to be on the agenda of all organizations, their field of action differs and not all of them support for example single technologies.

Basically, two main targets have been identified. First, the non-governmental organizations strive for future mobility systems to be developed in a more flexible way and, additionally, shared mobility solutions need to be created in an attractive way to be most convenient for users (Interview with stakeholder 10, 19 June 2019). Second, NGOs desire to promote means of transport that are contributing to a new mobility system that is more efficient and environmentally friendly than nowadays (Interview with stakeholder 8, 17 June 2019). The NGOs perceive the need to become active and support this development, as industry alone will not necessarily advance towards this new future mobility systems by itself.

Therefore, authorities are vital to pave the way towards these target systems by coming up with adequate regulations. Otherwise, NGOs fear to end up with a mobility system that is revealing more problems and thereby creating more environmental damage than it is offering solutions. (Interview with stakeholder 10, 19 June 2019). This is exactly where NGOs start playing an important role. To achieve their targets, NGOs for this reason give recommendations for policy building (Interview with stakeholder 9, 18 June 2019). While their lobbying activities might vary in the level of influence and their addressed governmental level, the purpose to influence policy building in benefit of our environment is perceived as rather homogeneous. On the other hand, their scope of action is very heterogeneous: some of the organizations commission for example their own studies and are actively doing research, while others tend to build their recommendations on the results of others (Interview with stakeholder 10, 19 June 2019. Interview with stakeholder 8, 18 June 2019).

"I see mainly two big uncertainties: The first one is whether autonomous vehicles will be electric (…). The spin of the role is that these autonomous vehicles will be electric, and everybody seems to take it for granted. But actually, if you don´t put any legislation ensuring that this autonomous vehicles should be electric, you still run the risk of having typically vehicles on the road that will have a higher mileage than the average car and either have a combustion engine, will lead to more emissions over their whole life cycle (…). For me, the second risk is also that these vehicles are not shared but privately owned. And if they are privately owned, you could end up with the congestion hell (…). If you don´t share these autonomous vehicles, you run a huge risk of making your congestion problem even worse." (Interview with stakeholder 10, 19 June 2019). Regarding Autonomous Driving (AD), NGOs see this technology as an option that can be reached in the middle to the long-run (Interview with stakeholder 8, 18 June 2019). They also observe that it could offer great benefits in terms of emission savings and congestion reduction, or in including people that are so far excluded from transport, e.g. people with reduced mobility (Interview with stakeholder 10, 19 June 2019). Even though there are benefits on one hand, undeniable uncertainties are arising. A major concern for the NGOs is the drivetrain – will alternative propulsion systems (e.g. electric, fuel cell, etc.) or an internal combustion engine be applied in the autonomous vehicles? Further uncertainties raise questions regarding the ownership of autonomous vehicles and the integration into the mobility system. Within the future mobility systems, will autonomous vehicles be owned by every

single household, or will autonomous vehicles replace and complement public transport systems? (Interview with stakeholder 10, 19 June 2019). Equally important is the uncertainty of the effects of autonomous vehicles. Combining electric vehicles and autonomous driving could result in a much more efficient way of driving and improve public transport immensely (Interview with stakeholder 8, 17 June 2019). Insecurity also refers to a geographical difference. While one measure could perfectly work in a certain area of one city, it does not necessarily imply that the same measure would also be as efficient in another area (Interview with stakeholder 8, 17 June 2019. Interview with stakeholder 10, 19 June 2019). As a consequence, NGOs lack and need a more solid ground and knowledge concerning the probable effects when scaling up autonomous vehicles in our mobility system.

3.5.2. Interest / attitude

"People are really overly optimistic in technology and say: look, we have many test beds here, it works, we have x kilometer driven, and actually we can deploy it like in two years. Well, it might be a bit more complicated than that." (Interview with stakeholder 10, 19 June 2019).

When analyzing the interviews, generalizing the interest of each NGO regarding autonomous vehicles cannot be done easily. There is one factor which is evident: much more data for AD is needed. Much more data to get more knowledge have to be gained, as consequences that AV are not yet assessed and very few impacts are proven on a scientific way (Interview with stakeholder 8, 17 June 2019). Besides of this, the interest of the organizations in autonomous vehicles is differentiated: one could conclude that some organizations do not show very strong interest in autonomous driving yet (Interview with stakeholder 9, 18 June 2019). This can be traced back to the structure and internal organization of the NGOs, e.g. as no own studies are commissioned, no research can be conducted in their own field of interest. This characteristic may be taken negatively, but it is actually coherent with their policy to do not promote single technologies. For these organizations, it is just natural to not commission research by themselves and rather focus on mobility as a holistic system (Interview with stakeholder 9, 18 June 2019). They see their responsibility on a much broader level and do not focus on AVs or any other specific mean of transport per-se (Interview with stakeholder 9, 17 June 2019). Contrary, some organizations have a rather strong interest in the technology. As they aim on providing regulatory recommendations to promote the public transport system, they are searching for data and experience to base their recommendations on (Interview with stakeholder 10, 19 June 2019). To get this data, not only theoretical research is required, but also application in the field. Practically applying autonomous driving in the field demands skilled people in Europe. They will not only set technology in place, but also get further knowledge about gathering, interpreting and analyzing data in order to bring forward innovation.

Organizations also stated that the need of trained staff on autonomous driving technology was to take place in Europe. A lot of research is already ongoing in the USA, but as already stated previously, effects might vary when adopting measures from one continent to another. (Interview with stakeholder 10, 19 June 2019). Despite of a lot of interest and curiosity, NGOs still hesitate to be too overoptimistic in one technology, as it might not be the solution to all the problems that mobility systems are currently facing (Interview with stakeholder 10, 19 June 2019).

When conducting the interviews, distinct barriers have been mentioned. First that came into mind was the question of standardization. In this context, standardization referred to the communication and linked requirements, e.g. 5G network and infrastructure expansion. Standards would facilitate not only further development of AD, but also have potential for manufacturers and the industry to save a lot of money. As long as such standards do not exist, manufacturers and industry might hesitate to invest further. (Interview with stakeholder 10, 19 June 2019). By developing appropriate standards, the implementation could be fostered, and investment could rise. Another barrier describes the uncertainty of effects for data capacity of the AVs (Interview with stakeholder 10, 19 June 2019). Environmental impacts for these data capacities are not assessed yet, so it is hard to draw any conclusion or recommendation. For a single autonomous vehicle, it might not be of that great importance, but knowledge should be gained before

scaling it up. In regard of data, security of data and data protection are always perceived as a potential barrier. It is questionable, whether users are willing to give their data and agree on the offered data protection solution (Interview with stakeholder 8, 17 June 2019).

When talking about the implementation of AD, one should not only consider technological feasibility and take interest of industry into mind, but should also ask consumers and citizens, upon which level of AV automation will they be comfortable to surround themselves with (Interview with stakeholder 10, 19 June 2019). Generally, our society tends to be to overconfident into technology and expects it to solve all our current problems. Unfortunately, technology is just one way to reach the target system. Using technology still exposes us to problems, e.g. the question of passenger security during off-peak and low demand hours (Interview with stakeholder 9, 18 June 2019). So far, there are also not all juridical and ethical questions properly addressed and solved (Interview with stakeholder 9, 18 June 2019). Additionally, politicians should work on policy building and solve fundamental issues like how far do we as society want to drive this technology forward (Interview with stakeholder 8, 17 June 2019).

Another barrier that has been identified is the position of insurance companies (Interview with stakeholder 9, 18 June 2019). For now, they have not developed any corresponding framework for AVs to support the implementation. Insurance companies cannot be held responsible for not taking actions, as their solutions have to be based on a well-defined political framework in place. NGOs have not only from a social point of view identified a number of barriers, but they see also barriers from a technical point of view. Contrary to social barriers, technical obstacles are perceived to be addressed and solved much easily. The reason that solving technical issues easier is the financial interest of the industry to work on the development of AD. They are much more motivated to put AD technology in place and spend much more effort and money, as they expect to gain out of a successful implementation. (Interview with stakeholder 10, 19 June 2019). A fact that is still unclear, is the speed of AV. It is not yet clear how fast AVs will be able to drive within an urban public transport system and what consequences thereby will result. (Interview with stakeholder 9, 18 June 2019).

Taking all these barriers into account, it can be concluded that the interviewed NGOs have not yet taken position in favor or against the AVs. They are neither supportive, nor opposing, but they are indifferent, and this might be the result of a lot of uncertainty about AD.

3.5.3. Offered solution

Even though NGOs might not offer products in a typical way, like for example vehicle manufacturers do, they do contribute to the integration of AVs into public transport. By lobbying, they do influence the policy making of governments and legal authorities. (Interview with stakeholder 8, 17 June 2019. Interview with stakeholder 9, 18 June. Interview with stakeholder 10, 19 June). Thereby, they are indirectly involved in determining a legal framework. In order to determine the right recommendations for governments and other involved parties, scientific data need to be gathered and provided to authorities.

Before particular recommendations can be given, the correlation between AVs and the advantageousness for the environment needs to be assessed (Interview with stakeholder 9, 18 June). This is of importance, especially for environmental NGOs with regard to place themselves in favor of or against AD. As mentioned earlier, NGOs differ in terms of their described approach to either promote certain technologies or to rather focus on the efficiency of the entire mobility systems.

Some of the organizations promote certain technologies and solutions, if they are favorable from an environmental point of view or protect the climate. Others have a more macroeconomic perspective. In other words, NGOs would politically intervene to develop a framework in a way that certain technologies are extensively applied, if a systematic approach is good. Within this approach, AVs can play a role, but inevitably do not have to. (Interview with stakeholder 10, 19 June). The reason is that they work to

increase the utilization of public transport, but yet, some of them do not see why AVs need to be implemented as one possible mean of transport (Interview with stakeholder 9, 18 June).

3.5.4. Resources

As this stakeholder group focuses on NGOs, material resources are scarce. But over the last years, with ongoing discussions and awareness of society for the environment, the organizations gained a lot of influence and became of more importance. This strengthened position could be achieved thanks to increased influence via media. By interfering via different media channels, NGOs managed to reach different target groups. (Interview with stakeholder 10, 19 June). Alongside of medial interference, the NGOs also have an influence on authorities and policy building (Interview with stakeholder 8, 17 June. Interview with stakeholder 9, 18 June). Especially as these resources are more of an immaterial nature, they should not be underestimated, and integration of NGOs should be ensured to guarantee a successful implementation of AD within a public transport system.

When talking about missing resources of NGOs, obviously funding will always pop up as the first missing resource, as these organizations are not profit oriented. Of course, each of these organizations strive to increase their influence and wish to have more impact. As a matter of fact, not only NGOs, but also other stakeholders might wish to get more insights about the application of AD in Europe. As mentioned earlier, data are available in a much more extended way for the US, but due to geographical and structural differences are not transposable. (Interview with stakeholder 10, 19 June). Not to mention the availability of social, environmental and economic data in general for AD. These days still a lot of issues remain unclear, and as long as these topics will not be investigated further, NGOs cannot include AD in their recommendations. Last but not least, the technical resource is not yet as mature as one might desire. This was also addressed as a resource that is not yet available. (Interview with stakeholder 8, 17 June).

3.5.5. Perceptions of other stakeholders

The network wherein stakeholders interfere is very diverse and not all NGOs are operating to the same extent with all the partners mentioned below. Mainly, NGOs collaborate with four groups: corporations, NGOs, publicity (associations and authorities), and research institutes. To cover technical aspects, NGOs work together with partners that have a corporate interest, e.g. Waymo, Tesla, or Uber, but they ally also with some companies of the telecom industry. (Interview with stakeholder 8, 17 June. Interview with stakeholder 10, 19 June). Of course, there is an interaction among the NGOs themselves. Due to organizational reasons and similar to a holding company, some NGOs are linked stronger than others. Within this collaboration, Transport & Environment as well as the International Council on Clean Transport (ICCT) are mentioned several times. Equally important is the collaboration of public organizations and associations. NGOs team up with the "Fédération Internationale de l'Automobile" (FIA) and other automotive associations, association of environment, traffic, and transport companies, consumer organizations and municipalities. The fourth group is the one enabling the organizations to get their base for recommendations. NGOs either assign their own studies, they commission studies, or they use data gained from studies conducted by independent research institutes. Among others, the German Institut für Energie und Umweltforschung (IFEU) as well as the Ökoinstitut were mentioned while conducting the interviews. (Interview with stakeholder 8, 17 June. Interview with stakeholder 9, 18 June. Interview with stakeholder 10, 19 June).
For informational purpose, NGOs stay in contact with research institutes, business organizations, sectoral associations, city organizations (e.g. Eurocities in Brussels), forward-looking governments like Finland, and other NGOs. Additionally, they keep updated by following certain media channels and collecting information of companies.

3.5.6. Stakeholder map

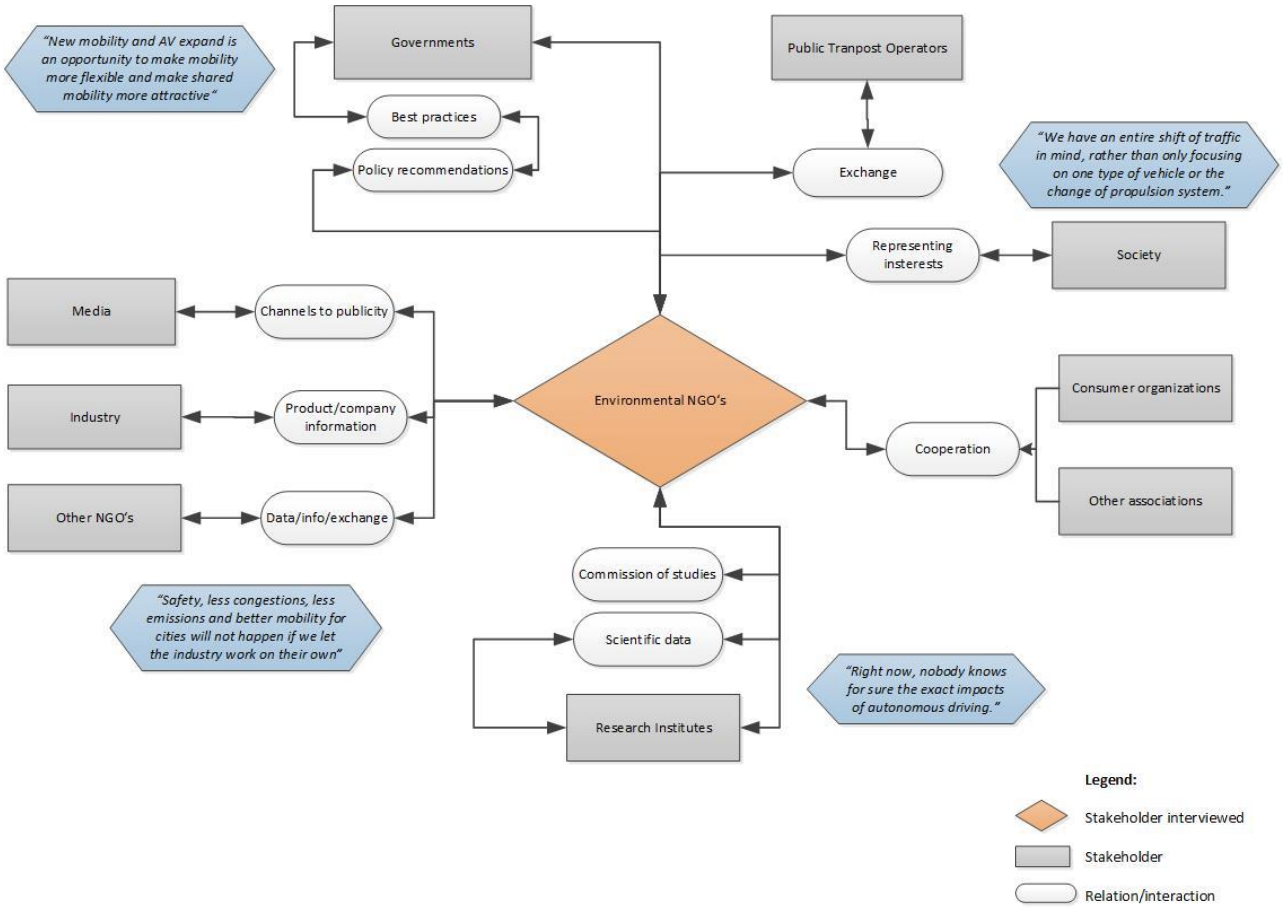

Figure 12: Stakeholder map from environmental NGOs' perspective

4. Implications for future research and intermediate conclusions

In order to sum up the results of all interviews, a workshop was scheduled with the objective to assess the first outcomes. Additionally, it was desirable to develop clusters or themes for the statements that the interviewees made. At the beginning, all the field researchers have written down information collected when conducting the interviews. Afterwards, same or similar ideas have been grouped together, and later on headings for these themes were defined. The setting of the workshop was very informal in order to leave as much space as possible for creativity and gather as much information as possible. Therefore, participants have taken notes on post-its and were allowed to add information whenever it came into their mind.

As preliminary result, the following themes have been identified: Future outlook, Regulation and Policy, No stable opinion, Bus drivers, Uncertainties and impacts, Needed information, Conflicts in opinion, Information source, Stakeholder interaction, Social acceptance, Market strategy, and Barriers and Resources.

In conclusion, the interviewed stakeholder groups picture the future outlook for autonomous vehicles in very different ways, meaning that each stakeholder is focusing on different issues to be addressed with the implementation of autonomous vehicles. Additional to different topics that stakeholders have in mind, they also have different attitudes towards the same topic. A good illustration of that is the future role of bus drivers in a system where autonomous vehicles will be applied. While the bus drivers themselves picture their current responsibilities to undergo a job enrichment, meaning that they will have to take over more ambiguous tasks, others perceive the job of bus drivers as not required for the operation of AVs.

Another important finding is that some of the stakeholders do not have taken position in favor or against autonomous driving yet. One reason for the in general rather unstable position might be traced back to existing uncertainties and the exact impacts of the technology. Many stakeholders claim that these days there is too few, reliable information available. This is not a surprising fact, because the autonomous driving technology is still a very new one and so far, there are still a lot of open issues to be further investigated.

Taking all this into account, it brings forth another point: The uncertainty and not clear impacts of autonomous vehicles in combination with the unstable position of stakeholders' results in a conflict of interest between the stakeholders. As already mentioned above, this conflict of interests can be due to the different future outlook various stakeholders might have about autonomous vehicles. However, it is not surprising that stakeholder's opinion and perspective about AVs vary, as different stakeholders base their perspective on different sources and interact in totally different networks. Consequently, these varying perspectives will result, among others, in new market strategies.

Notably stakeholders like manufacturers have so far always played a leading role in market competition and as they will not like to give up this position easily, they try to steer into one direction. Till recently, classical OEMs used to be market leaders in the automotive industry, but with the increasing extent of automation, new competitors drop into this market and shake the industry. Another point to take into account here is the investment linked with autonomous driving. To have at least some guarantee to invest into the right technology that later on will become reality, it would be desirable to have corresponding policies and regulations. That would give manufacturers at least to some extent security about their investment. On the other hand, introducing a legal framework would limit their freedom of developing products they perceive to be of value and to push them into the market. The government, however, faces

the dilemma that industry claims for the introduction of a legal framework for their technology, while on the other hand, authorities should have the needs and wishes of society and citizen in mind. Besides the very different paces, technology changes and development are very fast and dynamic, while the legal framework development requires longer time.

Before autonomous vehicles can be scaled up on a large scale macro-level though, some barriers need to be solved. These barriers are not only of technological nature, but especially address legal and social issues. To find solutions for all the listed barriers is not in the response of manufacturers and software developers alone, as they will not possess sufficient resources. Especially, social acceptance can become a great threat for putting autonomous minibuses in place. Another fact to be considered when analyzing stakeholders is to take a look at the resource equipment each stakeholder group has. In fact, each stakeholder group is rich of more or less similar resources, differing in quantity. Additionally, many interviewees raised the missing legislation and regulation for implementing autonomous driving and claimed that governments partly fail to put appropriate regulations in place.

This short reflection of the defined topics has been done in order to point out the complexity of the stakeholder interaction and to show the linkage between the different topics raised by the stakeholders. For the next deliverable, the identified categories will be used to compress all the interview results and based on this, further analysis will be done. During the workshop, the researchers also identified, that there are still important perspectives missing. To better understand the regulation procedure and explore deeper the interests of governments and authority institutes, it is recommendable that these stakeholder groups shall be taken into account and interviewed. Not only perspective of regulators and governments are of interest, but also users of the minibuses are of importance. In order to learn more about their influence and opinions, representative organizations, e.g. consumer organizations and citizen associations shall be interviewed, too.

Once all relevant information has been collected, meaning all outstanding interviews have been conducted, this will allow for another comparison. Stakeholder maps based on different sources can be compared. In other words, the stakeholder map, which is based on literature and experts validation and can be found at the beginning of this deliverable (Stakeholder map based on literature review). On the contrary, the stakeholder maps derived for each stakeholder group (see chapter Public Transport operators, Manufacturers, Software providers, Driver unions and Environmental NGOs) are based on information gained out of the interviews. An additional analysis could consist on the differences between the two different types of stakeholders. On the one hand, there is the map based on data coming out of the literature and from a more theoretical point of view, meaning a top down and inductive approach, whereas on the other hand there are the maps based on practical information, meaning a bottom up and deductive approach. Comparing these two different types of maps can reveal interesting facts and allow for further recommendations. These inductive and deductive methods should also be compared in the next deliverable.

Appendix I: Initial Stakeholder analysis matrix

Stakeholder group	Individual stakeholders	Interest in problem/issue (High/medium/ low)	Attitude Supportive / opposing	Resources that they posses	Resources that they lack	Importance of resources (High/medium/ low)	Interaction
				• Financial (money, access to credit, etc) • Institutional (formal legal, regulatory) • Social (position in network, access to public, public opinion/support • Technical (knowledge and expertise, technical skills, tools, etc)			
Consumer	-	High	Supportive	- power of decision - Social	- Technical	Low (for private electrical vehicles more important, but its public transport)	-
Transport operators (public)	Companies owning today's mobility, DB, TGV, RENFE, NS	High	Indifferent	- Finantial - Social	- Technical (at the moment)	High	-
Transport operators (public)	Keolis	High	Supportive		Technical Operational	High	Government, Manufacturers Software/platform provider, Society
Transport operators (public)	Sales-Lenz	High	Supportive		Technical Operational	High	Government Manufacturers Software/platform provider, Society

Transport operators (public)	TPG	High	Supportive		Technical Operational	HIgh	Government Manufacturers Software/platform provider, Society
International organization for public transport	International organization for public transport (UITP)	High	Ambivalent	Social; network organization for public transport operators. They lobby in the EU and elsewhere.	Technical Financial power	Low	Transport operators, EU
Manufacturers	- Navya - Radars - Screens - Sensors -Cameras	High	Supportive	- Finantial - Technical		High	Software providers
New competitors	- A-Mobility	High	Supportive	- Inovation - Social -Financial	Technical Operational	High	Government Manufacturers Software/platform provider, Society
EU	European Union Countries – (not countries, but the EU as entity/actor)	High	Supportive	Institutional		High	EU member states

State level	State - Denmark	High	Supportive	Institutional: regularization, policies and development of national strategies, goals and actions plan that shape the future of mobility, Public funds		High	EU, other States members, Region and Municipalities
	State - France	High	Supportive	-"-		High	EU, other States members, Region and Municipalities
	State - Luxembourg	High	Supportive	-"-		High	EU, other States members, Region and Municipalities
	State - Switzerland	High	Supportive	-"-		High	EU, other States members, Region and Municipalities
Local level (Municipal)	Municipality - Copenhagen	High	Supportive	- Institutional: authorization for autonomous minibus to ride on public spaces, intermediation with other local key stakeholders - Infrastructure adaptation		High	

Local level (Municipal)	Municipality - Lyon	High	Supportive	-"-		High	State, Region, local stakeholders from the municipality
Local level (Municipal)	Municipality - Luxembourg	High	Supportive	-"-		High	
Local level (Municipal)	Municipality - Geneva	High	Supportive	-"-		High	State, Region, local stakeholders from the municipality
Insurance company	Alianz Sura Avis Hertz	Low	Indifferent	- Finantial - Technical	- Social	Low	
Government (multi-level).	European Union States or cities where AV works	High	Supportive				

Infrastructure Charging stations	The Danish Ministry of Transport, Building and Housing	High	Supportive	- Institutional: formal legal authority to decide about infrastructure for mobility of the future	- Social: no access to public/ position in network, public opinion remains unclear - Financial: they get money out of taxes, but that will be not nearly enough to finance the entire transition in infrastructure - Technical: Knowledge and expertise yet can't be available as we are talking about inherently new technology	Low	Manufacturers, energy provider, customers, software developers, government (municipalities),
	Switzerland	Low	Indifferent				

France	High	Supportive	- Financial: unlimited access to credit/ high creditworthiness - Institutional: huge motivation to promote zero-emission vehicles and autonomous driving by government, possesses authority to put legal framework in place to implement these new technologies	- Technological: French government itself has no specific knowledge regarding infrastructure; they mostly depend on cooperation with other players, e.g. OEM, energy provider, charging infrastructure suppliers, ... - Social: Society is forced to accept green transportation as government is not offering alternatives	Low	OEM, customer, manufactures, software developers, NGOs, municipalities
Luxemburg						

	Charging stations in DK: E.ON, Clever, Clean Charging Solutions, Tesla	Medium	Supportive	- Financial: business model based on subscriptions and charges - Institutional: Empowered by the Danish Road Directorate, strong organizational structure - Technical: technical know-how available	- Social: public opinion is not clear	Low (for private electrical vehicles more important, but its public transport)	Vehicle manufactures, customers, government, software operator, transport operators,
Energy provider	EON	High	Supportive	- Technology: expertise and know-how, technical skills to produce the energy - Financial: As energy is produced by customers themselves, EON will only have to cover for the increasing infrastructure (at least parts of it)	- Institutional: missing regulation for setting up a network of infrastructure - Social: will customers all accept to generate their energy by themselves?	Low (as energy has to be generated by the minibus operators and charging stations will be also at the parking of the shuttles)	Government, manufactures, customers

Energy provider	Engie (Energie provider in France)	High	Supportive	- Technological: know-how, experience, technical skills and capabilities - Financial: business model based on their objectives - Institutional: partly owned by government	- Social (acceptance?)	Medium (Engie could be substituted by any other energy provider offering the same service)	Government, manufactures, customers
Software developers (operation of the vehicle + consumer platform)	Bestmile	High	Supportive	- Technological: know-how, experience and technical skills for developing and operating the platform - Financial: Business plan with a working business model for selling the platform	- Institutional: missing legislation for autonomous driving in some countries could endanger their business model - Social: How will they operate if society is not accepting AD?	Medium (as Bestmile could be substituted by any other software developing company)	Manufactures, transport operators, government, other traffic participants, infrastructure,
Software developers (consumer platforms)	Platform of local transport operators	Medium/low	Supportive	- Technology		High	Customers, manufacturers, transport operators, software developers, infrastructure, governments

Environmental NGOs	CERES (American NGO)	Medium	Supportive	- Technological: As they are cooperating with local manufacturers, they can use their know-how, experience and technical skills	- Financial: no money except donations - Institutional: Missing legal support for clean energy policies in the US - Social: unclear whether they have a good network	Low	Only indirectly related

Environmental NGOs	Greenpeace (German perspective)	High	Indifferent	- Financial: recollect subsidies for other purpose, expenses will be shifted towards electrification of public transport, donations - Social: Possess access to public via media platforms and connections to mobilizable troops - Technological: knowledge and experience in developing successful champagnes, possess manpower and human resources	- Institutional: unclear whether the German government is willing to stop subsidizing diesel-fueled vehicles	Medium	Only indirectly related

Environmental NGOs	Bund für Umwelt und Naturschutz Deutschland	Low	Opposing	- Social: possess access to public via media platforms and connections to mobilizable troops - Technological: knowledge and experience in developing successful champagnes, possess manpower and human resources	- Institutional - Financial	Low (as their resources can be provided by any other NGO interested in the problem)	Only indirectly related
Environmental NGOs	Climate Action Network (Europe), European Environmental Bureau, Climate Reality Project, Friends of the earth	Low	Indifferent			Low	

Environmental NGOs	Transport & Environment	High	Supportive	- Institutional: lobbying, publishing data and statistic, uncovering the emission cheating in 2017 - Social: possess access to public via media platforms and connections to mobilize troops - Technological: knowledge and experience in transport activities and how to develop successful campaigns, they also possess manpower and human resources	-Financial: donation based only?	Medium	Governments, EU, Manufacturers,
Unions	Transport Operators	Medium	Opposing	- Governmental - Institutional		Low	Transport operators, local municipalities,
Assessment agencies	General						
	France						

(especially Denmark)	Denmark, Danish Road safety Agency	Medium	Supportive, but critical	Institutional; they can allow or deny tests with autonomous minibuses.	They cannot change the laws.	Medium	The assessment is made together with the National Police (Rigspolitiet) and State Prosecution Service (Rigsadvokaten)
Recycling industry (batteries)		Low; they don't see a different in normal electric cars, autonomous electric cars or autonomous minibuses	Indifferent	Technological know-how on recycling process.		Low; currently the cost for new resources is cheaper than recycling	
Recycling industry (batteries)	Retriev Technology	low; the end-of-life batteries can be their resources, but no specific interest in autonomous minibuses	Indifferent	- Financial: they do not only count on car batteries, but also on other batteries and additional customer solutions - Technical know-how on battery recycling	- Legislation: binding standards for recycling batteries - Institutional: missing network for downcycling of vehicle batteries	Low, as the AVENUE project does not depend on recycling system in place	Battery manufacturers, vehicle manufacturers, legislator

Recycling industry (batteries)	Umicore (umicore.com)	low; the end-of-life batteries can be their resources, but no specific interest in autonomous minibuses	Indifferent	- Financial: not only recycling business, but also other business divisions - Technical know-how on recycling process	- Institutional: not enough/ strong enough regulations regarding recycling		Manufacturers
Legislators		High	Amibivalent	Legislation: Law of Vehicle Approval & Public Transport Law &Law of Driving Licenses	- Technical: missing expertise for autonomous driving	High	Research institutes
Emergency aid (fire, policy & ambulance)		Low / medium: Majority of accidents on roads are caused by human failures, therefore autonomous vehicles could result in safer roads	Positive			Low	Infrastructure department, legislators

UN	UNECE, the only United Nations body dedicated to inland transport	Low	Indifferent	Institutional and Technical: policy dialogue, negotiation of international legal instruments, development of regulations and norms, exchange and application of best practices as well as economic and technical expertise, technical cooperation for countries with economies in transition. [4]		Medium	Policy makers, legislators, governments, international relations.
Industry lobbies	Society of Automotive Engineers (SAE) International's On-Road Automated vehicle standards committee	High	Supportive	Social Institutional (due that they work with EU and Multi gob. Level)		High	Manufacturers, lawmakers

Trade Unions	- European Transport workers Federation - International Transport workers Federation	Low	Opposing	"Social Institutional (due that they work with EU and Multi gob. Level)"	Finantial	High	Driver's working conditions, lawmakers
Research institutes	Institut für Kraftfahrzeuge RWTH Aachen	High	Supportive	- Technical: knowledge and experience in autonomous and driving, additionally separate institute for electromobility at RWTH Aachen, manpower available due to the size of the institute - Social: good reputation in society and research area, research is highly valued	- Financial: foundation due to specific projects depending on the partners	Low	Mainly technology provider (vehicle manufacturer, software developer, infrastructure, energy providers, ...)

Research institutes	Computer Science and Artificial Learning Laboratory (CSAIL) Massachusetts Institute of Technology (MIT)	High	Supportive	- Technical: knowledge and experience in artificial intelligence, manpower available due to the size of the institute - Financial: access to credit via "investors" e.g. government, industry (e.g. Toyota), ... - Social: good reputation in society and research area, research is highly valued		Low	Manufacturers, customers,

Research institutes	Toyota Research Institute (TRI)	High	Supportive	- Technical: Knowledge and expertise in artificial intelligence, Technical skills and capabilities to research - Financial: Money, capital other financial assets of Toyota, great access to credit - Institutional: strong Organizational tissue due to ownership by Toyota - Social: good interaction with other research institutions	-	Low	MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL), The Stanford Artificial Intelligence Laboratory (SAIL), University of Michigan

Research institutes	Mechanical System Control Lab UC Berkeley	High	Supportive	- Technical: knowledge and experience in artificial intelligence, manpower available due to the size of the institute - Financial: access to credit via "investors" e.g. government, industry, ... - Social: good reputation in society and research area, research is highly valued		Low	Manufacturers, customers,

Research institutes	Research club Automated Driving DELFT (RADD)	High	Supportive	- Technical: knowledge and experience in artificial intelligence, manpower available due to the size of the institute - Financial: access to credit via "investors" e.g. government, industry, ... - Social: good reputation in society and research area, research is highly valued		Low	Manufacturers, customers, TU Delft, Metropoolregio Rotterdam Den Haag, the Municipality of Delft, and the Province of Zuid-Holland Additionally, the RADD is part of a cooperation between governments, knowledge institutions, and small and mid-size business entrepreneurs in the region

Consultancy firms	McKinsey	Low	Supportive	- Financial: money available out of other business divisions, high creditworthiness - Institutional: strong and clear internal organization	- Social: good position in network and good access to public, but is their reputation valid to build up user trust? - Technical: manpower and methodical approach might be available, but actual knowledge is provided by the customers of the consultancy firms	Low	Mainly with industries
Consultancy firms	PWC	Low	Indifferent	"	"	Low	Mainly with industries
Consultancy firms	KPMG	Low	Indifferent	"	"	Low	Mainly with industries
Consultancy firms	Deloitte	Low	Indifferent	"	"	Low	Mainly with industries

Siemens AG	High	Supportive	- Financial: easy access to credit in various ways by great creditworthiness - Technical: knowledge and expertise in software development, simulation and model	- Social: presence in networks - Institutional: Siemens company is highly efficient organized, but that organization does not change anything about the formal obstacles they might face in terms of AD	Low	Vehicle Manufacturers, Software developers,

Appendix II: Topic list

Methodology	**n=14 in-depth interviews** **duration determined by interviewee** **(at least 60 minutes, max. 2 hours)**

Sample structure:

Stakeholder
• **4 stakeholder groups for this phase;** • 3- 4 interviews per stakeholder group
• **additional stakeholders as opinion leaders, city councils, political influencer, citizens' initiatives etc. (at later AVENUE stages)**

***Key topics*:**

- Role of interviewee in organization
- Introduction of organization
- Perception on autonomous mobility
- Perception on autonomous minibuses integrated in public transport
- Barriers, risks, obstacles and solutions
- Resources
- Information behavior
- Relation to other stakeholders

Guideline:

- To provide respondents a maximum level of openness the guidelines determines the topics in detail but does not determine accurate direct questions.
- At the start of the interview, we ask for personal introduction & attitudes, in the remaining of the interview, we are interested in the perceptions, goals, resources etc. of the organization.

General Introduction **about 5 min.**

- Introduction to AVENUE (EU project, aim to demonstrate the usefulness of integrating autonomous minibuses in public transport, role of HS-PF, goal of stakeholder analysis, methodology of qualitative interviews)
- Data protection declarations
- Request for audio recording
- Use of citations for reporting
- Introduction of the interviewer

I. Warm-Up **about 5 min.**

Aim: Introduction of the **interviewee**

- Professional background, professional career
  as technical, economic, political, social, psychological background
- Current areas of responsibilities

II. Involvement, Attitudes, Expected Trends regarding mobility and autonomous mobility about 10 to 20 min

Aim: Identifying the interviewee's role within his/her organization with regard to autonomous vehicles. Understanding the role and interests of the organization.

How would you describe the role, the specific interests, strategic goals or even responsibilities of your organization with regard to introducing and establishing autonomous public vehicles (minibuses in the first place) in your community/city?

With regard to your own person but as well with regard to your professional tasks, what do you think about mobility in general, public transport and finally autonomous vehicles in special?

CHECKLIST

- Description of organization (public, private, civil society)
- Autonomous mobility involvement concerning e-mobility, autonomous vehicles (core objective of organization; affair of their heart, are they open-minded, neutral, enthusiastic or skeptical)
- Future trends, developments concerning mobility in general: multimodal integrated mobility on demand and ticketing
- Expectations towards different target groups, attractive market segments, application fields
- Customers of organization? Value they are proposing to add.
- End Users of autonomous vehicles (e.g. general people, scholars/commuters, tourists, shoppers, weekenders &'night owls')

III. Perception on autonomous minibuses/pilot **about 10 to 20 min.**

Aim: Involvement and perception on integration of autonomous minibuses in public transport

Now I'd like to go into more details concerning autonomous vehicles especially autonomous minibuses. You may know there will be a pilot in your city. What do you know about this pilot so far?

(If respondents are not yet involved, some prepared background information is given).

IV. Perceived barriers, risks, obstacles and solutions about 10 – 15 min

Aim: Identifying the barriers and obstacles that the interviewee's organization perceives, and the solutions proposed to overcome these barriers

Which upcoming barriers and obstacles regarding autonomous public transports does your organization foresee?

Checklist:

- Formal regulations (policies, rules, etc.)
- Cooperation with other actors
- Social acceptance
- Improve technology
- Desired automation
- control and monitoring levels
- Level of acceptance of different service and business models
- Reduce environmental impact
- Public vs. private mobility
- Security

V. Resources of interviewee's organization about 10 – 15 min.

Aim: Identify the resources that the interviewee's organization possess to resources

What resources does your organization possess that help to reach to the solutions proposed, what resources are missing?

Checklist:

- Financial resources
- Institutional resources
- Technical resources
- Social resources

VI. Identification of other Stakeholders, information behavior about 10 to 15 min.

Aim: Identifying important stakeholders

What other stakeholders/organizations does your organization cooperate with, depend on, or have regular interaction with?

Which of these stakeholders are most crucial for enabling autonomous public transportation and why?

Checklist:

- Customers
- Partners for cooperation
- Stakeholders that they depend on for their success
- Public organizations, private companies, civil society organizations
- Opponents and supporters of AVENUE goals
- New competitors (Google, Apple, Uber, etc.)

VII. Information behavior **about 5 to 10 min.**

Aim: Identifying relevant sources for information

What sources of formal and informal information does your organization rely upon?

Checklist:

- Formal and informal information
- Social networking
- Interaction with other stakeholders
- Important influencers
- Working groups, personal network

VIII. Wrap Up – Final Self-Reflection **about 5 to 10 min.**

Aim: Invite interviewee to address to topics that we have not yet touched upon

Thanks for your time and the information provided. Are there any themes/issues regarding autonomous public transport that you would like to discuss with us?

MANY THANKS FOR THIS INTERVIEW!

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